MECHANICAL ENGINEERING

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 71 · NUMBER 4

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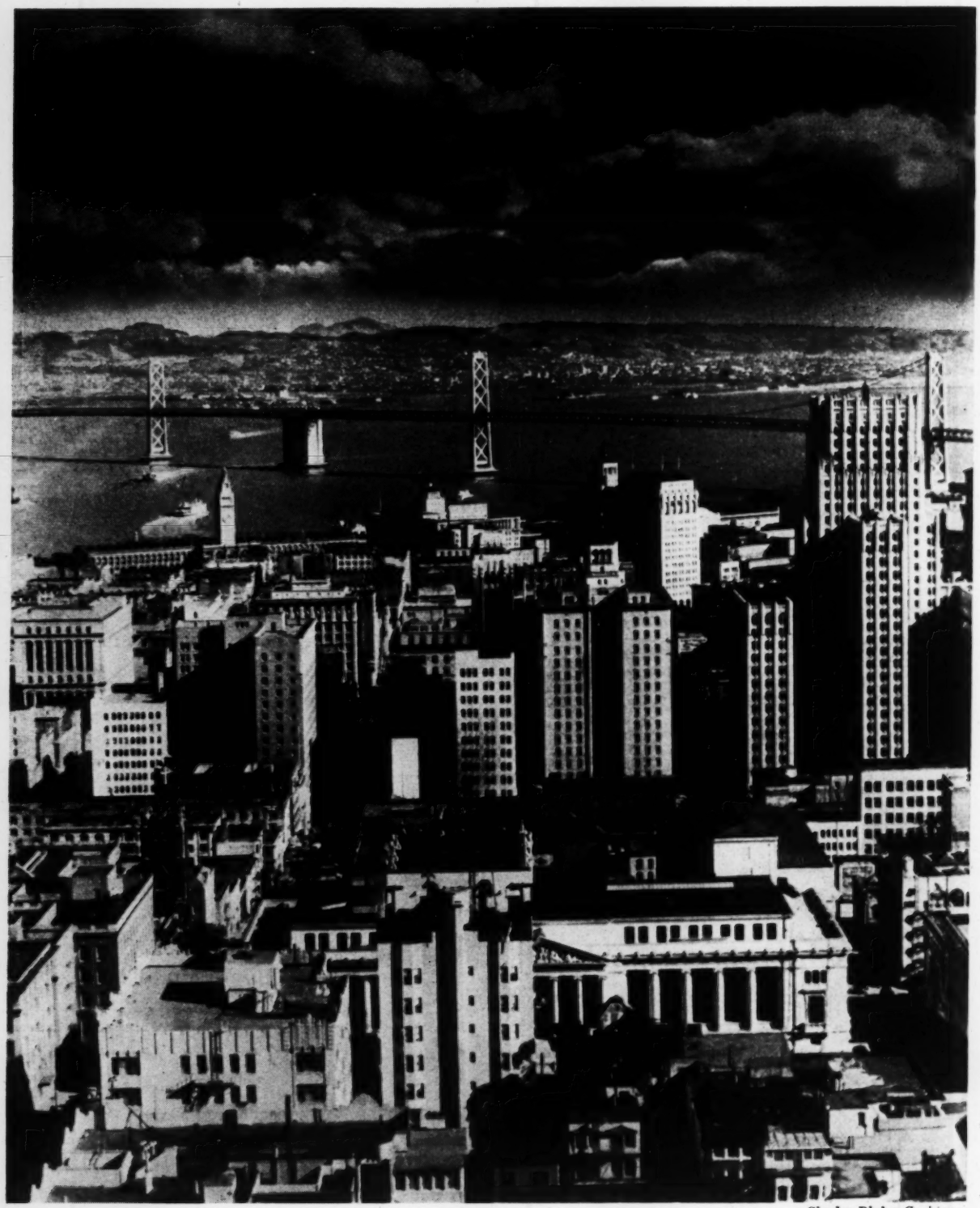

Charles Phelps Cushing

Skyline of Downtown San Francisco

(*See page 365 of this issue for story of ASME Semi-Annual Meeting at San Francisco, Calif., June 27–30, 1949.*)

VOLUME 71
No. 4

MECHANICAL ENGINEERING

APRIL
1949

GEORGE A. STETSON, *Editor*

Plight of Physicists

AN article on the scientists, that appeared in the October, 1948, issue of *Fortune*, stated that "the splitting of the atom . . . . also annihilated the last of the nineteenth-century notions of an inevitable millennium," and quoted J. Robert Oppenheimer, who headed the bomb-building laboratory, as saying: "In some sort of crude sense, which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known sin; and this knowledge they cannot lose."

The moral conflict in the minds of physicists was immensely intensified by the destruction wrought at Hiroshima and Nagasaki, but it did not originate there. Its origins go deep into the history of science, but relatively few persons concerned themselves with the problems and the solutions. The nineteenth century had its own rude impacts, as indeed had earlier times. It was no easy adjustment to make to admit the validity of the teachings of Copernicus and Galilei. Even in our own times the evolutionary theory of Darwin has been in conflict with stoutly held religious beliefs and has dragged our universities into the courts. It was only yesterday that Kelvin's second law was distressing men's minds with thoughts of the "heat death" and the philosophical consequences of the principle of degradation of energy. But in our own age scientists shrugged their shoulders at the conflicts their discoveries injected into the lay mind, and went about their special studies searching for truth as they found it, unafraid of what it might reveal, confident that it was all for the best in the long run. Indeed, so accustomed were the mathematicians and the physicists, particularly, to thinking of their work as being somewhat apart from the daily lives of men, and so long and so gradual was the introduction of their findings into those lives, that intellectual and moral detachment was natural. One's purpose was research, discovery, additions to knowledge. Let others apply the knowledge thus won. Let others concern themselves with the consequences. Science knew neither good nor evil. Only men were good or evil. The responsibility of use was not that of the scientist.

The atom bomb shocked the physicists quite as genuinely as it did laymen. They had unloosed a power which, contrary to most precedents, was quickly put into use and the use was one of destruction. The great moral problem, knowledge without wisdom, burst suddenly into the consciousness of men who were essentially moral creatures even though they might recognize no morality in science. Thus Hiroshima and Nagasaki became symbols in a dramatic sense, and the physicists knew sin. The walls of the laboratories were destroyed, and what went on within was no longer solely of academic interest to the workers. The work of the physicist immediately affected not only himself but his family, his neighbors, his fellow men, the very existence of civilization itself. It had acquired a moral significance.

Plight of Engineers

THE plight of the physicist has its parallel in the plight of the engineer. Engineering developed out of the mechanic arts, rather than the quiet of the university research laboratory, and hence has always been close to the lives of men and to the improvement of human welfare. Its development paralleled the development of Western industrial civilization. When it became influential in civil, as contrasted with military, affairs, and a group of men emerged who called themselves engineers, the well-known definition was written which describes it as "the art of directing the great forces of power in nature for the use and convenience of man . . . ." In later versions the words "use and convenience" are frequently replaced by the terms "benefit" or "welfare," and it is in the performance of this task that the high purpose of engineering as a profession has found expression. Whether wittingly or not, those who framed such a definition endowed engineering with a moral purpose, with a human quality which transcends the material qualities it shares with science.

If, as Dr. Oppenheimer has attested, physicists for the first time knew sin when they unlocked nuclear energy and made the atom bomb, the experience was an old one for engineers. For it will be remembered that out of the Industrial Revolution flowed social consequences which remain with us today. The steam engine and the machine broke up the cottage system of production which was characteristic of the eighteenth century and substituted for it the factory system. The benefits that engineers had bestowed upon the world were reaped, in that era of enslavement of man to the machine, not by the men, women, and, shameful though it was, the children, who tended those machines but by the few who owned them. Thus the machine became, in certain ways, a reproach to its creator, a reproach which engineers ever since have been trying to remove. Like the physicist of today, the engineer sought to absolve himself of blame. Was it his fault if other men seized the power for production and profit that the machine had unloosed? Engineering, like science, knew neither good nor evil; only men were capable of such affronts to

universal brotherhood. How differently we view it today.

But engineering did not long confine its talents to the purely mechanical areas in which it made its early spectacular progress. It found that it was forced, if it would make the most of that progress, to direct its attention to man himself and to his development and progress. In this area it discovered that the methods which returned rich material rewards were also helpful in improving human welfare.

To the glory of engineering let it be remembered that when men of vision, trained in its arts, were elevated to positions of responsibility in the conduct of industrial enterprises, they set about it to remove the reproach that had been laid upon them in the days when scant regard was paid to the dignity of human labor, and endeavored to use their skills for the benefit of mankind, to fulfill a moral as well as a technological purpose.

Plight of Society

THE depression of the nineteen thirties brought yet another shock to engineers and preceded by a decade and a half the one which the physicists have recently suffered. In the midst of an era when technology was at its height, when it seemed as though man had at last unlocked the secrets of abundance and economical production, when material progress was rapid and the wants of those who were suffering from hunger and backward ways of living were on the verge of being satisfied, something went wrong. The production machinery halted and almost stopped. Poverty and unemployment harassed the Western nations and fear gripped men's hearts—the fear of economic insecurity, of starvation in a world of plenty.

Engineers who lived through those trying years and who survived only to be plunged into a world war which brought widespread and devastating consequences are every bit as competent as they were twenty years ago; nay, they are more so; and they have advanced their skills and techniques to such an extent that they should be able greatly to increase the benefits they might shower upon their fellow men through the medium of economical production. To a greater extent than ever before they are exercising their talents in fields outside but close to those that are strictly technical in character. And they are coming to the realization of the importance of the greater task that lies before them, the task of doing their part in establishing and maintaining economic and social stability.

Leaders of the profession caught this vision of the direction in which engineering was tending during the depression. They knew that technologically their profession was competent and capable of maintaining its forward accelerated progress. But they were not so sure that the great mass of engineers would leave their technological isolation for the world of human affairs.

It would be pleasant to live entirely within the world of truth and order that is the realm of science and engineering, there to apply the principles of nature to engineering endeavors, where results can be predicted and where there are no uncontrollable human forces, unsubservient to the known laws of nature, to bring discord into the harmony of science. But the progress of history has taught us that this cannot be the portion of the engineer, no matter how humble his position in his profession may be. For science and engineering pervade so completely all aspects of contemporary living that a larger view must be taken.

It is in this larger area of engineering influence that engineering societies have begun to operate. There are still large groups of engineers who prefer to stay within the small circle of activities and interests where technical competence is the sole measure of success. No one will deny that this technical competence is the basis of every engineer's capacity to be of service. If he neglects it he will surrender the principal advantage of his position. But under today's conditions the engineering societies cannot retain an isolation that was characteristic of the early days of their history. Nor can publications, such as this, refuse to mix with their technical fare such food for growth in the areas on which engineering exerts its influence as can be provided by the articles written by engineers who are working in them.

Engineers are heavily in debt to the scientists. The engineer is the applied scientist. It is he who puts into practical use a large portion of the discoveries of science. He has adapted the methods of science to the solution of the problems that confront him. He has accepted the fundamental facts of science as the fundamental facts of engineering. The scientist can make out a very good case for shifting his recently acquired sense of guilt onto the shoulders of the engineer and society itself. For the function of the scientist is the discovery of truth in nature; the function of the engineer is the application of the discovery to practical use. Blame is attached to use and not to discovery. The scientist who is true to the ideals of his calling has no choice but to announce the truth as he finds it. He does not create truth; he uncovers it.

The scientist is essentially a moral creature with a sense of obligation to the society in which he lives. That society, and particularly the engineer members of it, must not permit any self-assumed sense of guilt to vitiate or bring to frustration the driving force of the search for truth that energizes the scientist. The guilt must be borne by society itself.

The engineer is grateful to the scientist for the fruitfulness of science. He must zealously protect the freedom without which the scientist cannot carry on his work. That freedom has already been denied in nations where the discoveries of science are in conflict with the political dogmas on which the authority and power of the state are based. In other nations that freedom is threatened, unintentionally, perhaps, by increasing political control of planned research.

It will be a sad commentary on human intelligence if science loses its freedom either because of the fear of society to face truth as it is uncovered, or because of the shortsightedness of politicians who may gain control of it. The engineer owes it to science and to society to help preserve that freedom.

The LOAD-CARRYING ABILITY *of* HYDRODYNAMIC OIL FILMS

A Review of Some Current Problems

By ARVID E. ROACH

RESEARCH LABORATORIES DIVISION, GENERAL MOTORS CORPORATION, DETROIT, MICH.

THE theoretical studies of Reynolds (1),[1] Sommerfeld (2), and others indicate that the load-carrying capacity of a journal bearing should be infinite. Similarly, studies (3) of the rate of convergence of flat parallel plates separated by an oil film indicate that infinite time is required to obtain contact between perfectly smooth surfaces; this also implies that the load-carrying capacity of a bearing should be infinite.

Theory deals with "idealized" bearings. Real bearings, however carefully fabricated, do not have infinite load-carrying capacity. What the actual load-carrying capacity of a real bearing is, however, is a question which has not yet been answered to the complete satisfaction of many engineers. Aside from the natural interest which always attaches to this question, it is of additional interest at the present time, since, under certain conditions of bearing operation, as in gas turbines and in high-speed supercharger drives, the load-carrying capacity may become substantially zero.

CRITERIA FOR LOAD-CARRYING CAPACITY

There are at least four criteria (4) which have been proposed for the load-carrying capacity of journal bearings. They are as follows: (*a*) Film rupture; (*b*) film stability; (*c*) film heating; (*d*) film thickness.

"Film rupture," or failure due to seizure, although relatively easy to determine experimentally, is perhaps the least useful of the various criteria for load-carrying capacity, since operation will already have become unstable before actual rupture of the film occurs. This is illustrated in Fig. 1, which is a plot of the Sommerfeld variable $(r/c)^2 (\mu N/p)$ versus the dimensionless friction coefficient $(r/c)(f)$, where r is the journal radius and c is the radial clearance. It may be noted that as lubricant viscosity μ, or speed N, is reduced, or as load p is increased, the curve passes through a minimum value of friction coefficient. To the right of this minimum value, operation is stable, that is, any increase in friction coefficient due to increase in load will be self-compensating since the increase in temperature due to the higher friction coefficient tends to reduce the viscosity of the lubricant, which in turn tends to reduce the friction coefficient to its original value. To the left of the minimum value of friction coefficient, however, the curve has a negative slope. This means that a decrease in viscosity tends further to increase the friction coefficient, leading to still greater instability.

The criterion of "film stability" takes account of the behavior described in Fig. 1. Here the location of the minimum value of the friction coefficient is adopted as a criterion for load-carrying capacity (5, 6). The ultimate load-carrying capacity is now the value of p, in the Sommerfeld variable, which corresponds to minimum friction coefficient. This criterion, while theoretically satisfying, involves practical difficulties, particularly in measuring the actual viscosity of the lubricant film, which limit its usefulness.

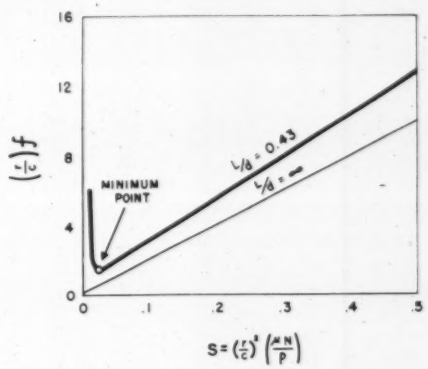

FIG. 1 TYPICAL PERFORMANCE CURVE FOR A FULL JOURNAL BEARING COMPARED WITH PETROFF'S LINE

"Film heating" has sometimes been proposed as a criterion for load-carrying capacity (7), since increase in temperature reduces lubricant viscosity which in turn reduces the value of the Sommerfeld variable. The maximum load-carrying capacity of a bearing is, in these terms, determined by the maximum permissible operating temperature of the lubricant film, which in turn is determined by the characteristics of the lubricant and by the heat-dissipating capabilities of the bearing. Here again there are practical difficulties, the most troublesome of which is the difficulty of measuring the actual temperature of the lubricant film.

Since the thickness of the lubricant film decreases with increasing load, the load-carrying capacity of a bearing may be expressed in terms of the film thickness below which there is likelihood of metal-to-metal contact (8, 9, 10). This may be termed the criterion of film thickness. Although probably the most widely used of all criteria for load-carrying capacity, there is considerable latitude of opinion regarding the permissible minimum film thickness for a given application. It will depend, among other things, upon the clearance, length-to-diameter ratio, surface condition, and film form. A practical limitation is the difficulty of measuring film thickness in an operating bearing.

EFFECT OF VARIATION OF VISCOSITY

In theoretical studies of lubrication, it is commonly assumed that the viscosity is constant throughout the lubricant film. While this assumption simplifies mathematical analysis, it has no basis in fact. Reynolds (11), Slotte (12), Vogel (13),

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Special Research Committee on Lubrication and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

and others early showed that viscosity decreases markedly with increase in temperature. Fig. 2 shows the typical behavior of mineral oils in this respect. The reduction of viscosity with increase in temperature results in an appreciable loss of load-carrying capacity. In order to take account of this effect in bearing computations, it is necessary to determine the temperature variation within the load-supporting film. But, as Hersey (14) pointed out over a decade ago, no aspect of lubrication research has been so systematically neglected as the true temperature of the lubricant film.

Of somewhat less interest from a practical viewpoint is the

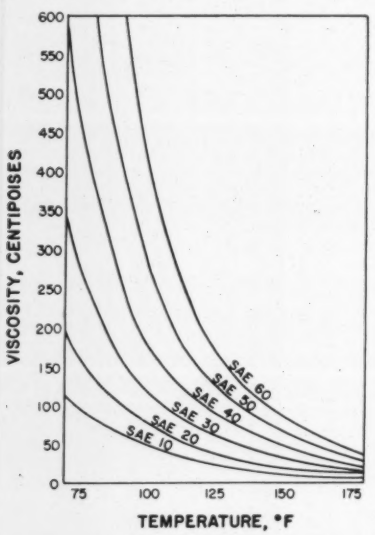

FIG. 2 VARIATION OF VISCOSITY OF SOME MINERAL OILS WITH TEMPERATURE

[After Norton, reference (41).]

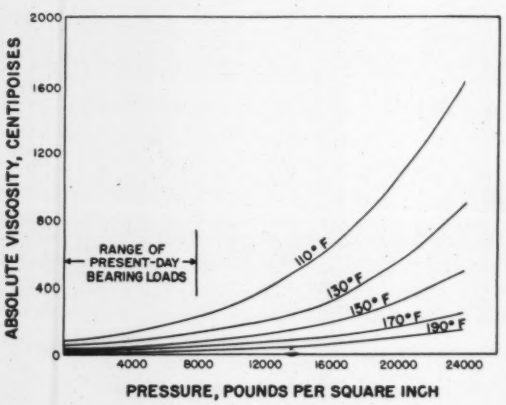

FIG. 3 VARIATION OF VISCOSITY OF A PENNSYLVANIA OIL WITH PRESSURE

[After Bradford and Vandegrift, reference (42).]

increase in viscosity with increase in pressure (15, 16, 17). As shown in Fig. 3, this effect does not become appreciable at pressures in the range of current bearing-loading practice due to the accompanying temperature-viscosity effect. It has been suggested (18) that some such phenomenon may account for the remarkably high load-carrying capacity of very thin films.

EFFECT OF SURFACE CONDITIONS

From the classical viewpoint, the effect of improving the surface finish of a bearing is to decrease the minimum value of the curve in the plot of Sommerfeld variable versus friction coefficient. It is usually assumed that, at this minimum value, the film thickness is of the same order of magnitude as the surface roughness so that incipient seizure occurs, causing an increase in friction coefficient with further reduction of the Sommerfeld variable. Increasing the smoothness of the surfaces is thought to move the minimum point further to the left, while with geometrically perfect surfaces it is assumed that a minimum point will never be reached.

Opposed to this classical viewpoint, there is a considerable body of opinion that roughened, porous, interrupted, and other geometrically nonperfect surfaces may be capable of supporting greater loads than extremely smooth surfaces. As applied to hydrodynamic lubrication, these opinions appear to be founded for the most part on two considerations (19) as follows:

(*a*) The lubricant must adhere to the bearing surfaces in order to form a load-supporting film.

(*b*) The thickness of the film is a function of lubricant viscosity at film temperature.

With regard to the consideration (*a*), it has been suggested that surfaces with small-scale interruptions provide a more suitable structure to which the oil film can cling. The essential question, which has been raised by Clayton (20), is whether such surfaces can be wiped free of oil as easily as a continuous one. Also pertinent in this connection is the question of the wetting qualities of lubricants on various bearing materials. It has been found that silver and some copper alloys, for example, resist effective wetting by certain oils.

With regard to the consideration (*b*), it has been suggested that by interrupting the surface properly, more may be gained from the increased cooling which results from increased area than is lost from reduced load-supporting area or from film discontinuity. In such a case it is assumed that oil-flow rates are low and that an appreciable portion of the frictional heat is dissipated by conduction through the bearing and supporting structure. In the usual case, oil-flow rates are sufficiently high so that the oil itself carries away most of the heat of viscous friction.

It is interesting that such diverse opinions, in many cases supported by experimental evidence, can exist side by side. Possibly much that is now in conflict can be reconciled by greater precision of definition. That there are such differences indicates the need for a thorough re-evaluation of surface character concepts and for serviceable standards of surface finish (21).

EFFECT OF LOAD CONDITIONS

The greater part of the literature on hydrodynamic lubrication deals with bearings in which the load is applied unidirectionally, that is, in one direction with respect to the bearing. However, in many applications, such as engine bearings, the load is of a dynamic character, and the magnitude and direction of the load change from instant to instant. That such bearings are capable of supporting greater loads than unidirectionally loaded bearings, with certain exceptions which will be noted subsequently, was observed at an early date (22, 23, 24). This increased load-carrying capacity is due to what may be termed "squeeze" action. Neglecting hydrodynamic effects for the moment, the effect of a load applied to a journal is to squeeze the lubricant from the clearance space between journal and bearing. The rate of escape of the oil is described by Stefan's law (25). When the load rotates, the squeeze acts on a given particle of lubricant only for an instant so that the film is not squeezed completely from the clearance space and is then afforded an opportunity to re-establish itself before the next load application. The load-carrying capacity of a dy-

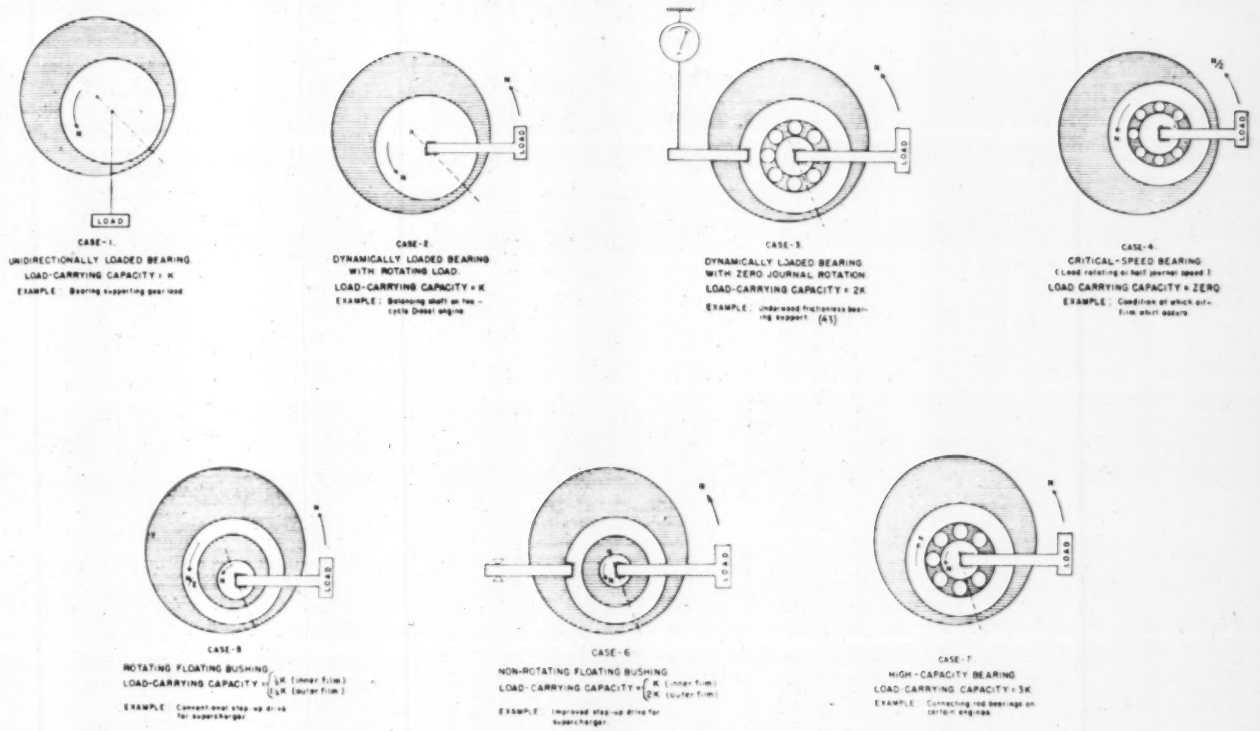

FIG. 4 SEVEN DIFFERENT TYPES OF BEARINGS COMPARED WITH RESPECT TO LOAD-CARRYING CAPACITY
[After Stone and Underwood, reference (26).]

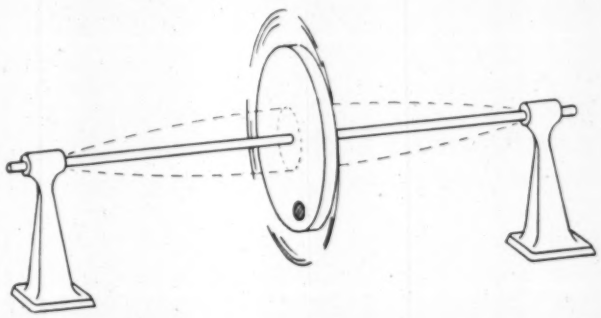

FIG. 5 UNBALANCED ROTATING SHAFT SUPPORTED BY FULL JOURNAL BEARINGS

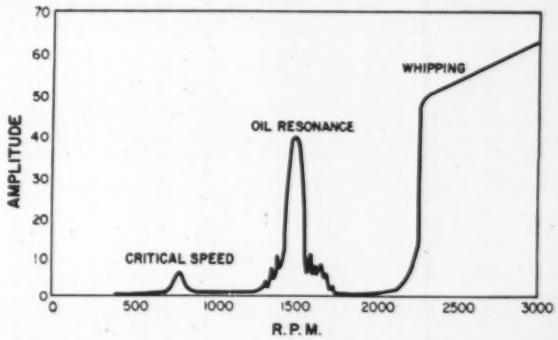

FIG. 6 THREE CONDITIONS OF VIBRATIONAL INSTABILITY EXPERIENCED BY AN UNBALANCED ROTATING SHAFT
[After Newkirk and Taylor, reference (28).]

namically loaded bearing results from a combination of squeeze action and hydrodynamic action, while the load-carrying capacity of a unidirectionally loaded bearing results from hydrodynamic action alone.

It has been shown (26) that the load-carrying capacity of a journal bearing under various conditions of loading may be expressed by the relationship

$$\text{Load-carrying capacity} :: (2N_L - N_J)$$

in which both the load velocity N_L, and journal velocity N_J, are with respect to the bearing. This relationship is useful as a means of comparing the effect of changes in load conditions upon load-carrying capacity. Fig. 4 illustrates the effect of seven different conditions of loading as computed by this relationship.

The fourth case, considered in Fig. 4, is the condition of oil-film whirl. Under this condition, although there is relative movement between journal and bearing, there is no relative movement between journal and oil film to maintain hydrodynamic action; hence, the load-carrying capacity becomes zero and metal-to-metal contact occurs between journal and bearing.

EFFECT OF SPEED CONDITIONS

A rotating system, consisting of the elements shown in Fig. 5, passes through three well-defined conditions of vibrational instability, as shown in Fig. 6 (27). The first unstable condition is the critical-speed vibration, or shaft resonance, caused by shaft elasticity. The second condition is the so-called oil-film resonance, occurring at approximately twice critical speed. The third condition is known as oil-film whipping, beginning shortly before 3 times critical speed and becoming increasingly violent with further increase in speed. In each case, the vibration of the shaft takes the form of a whirling action, in which the axis of shaft rotation travels around a circle or other curve instead of remaining at a fixed point.

At all speeds there are film pressures which act on the journal

behind the point of nearest approach between the journal and the bearing, tending to force the journal center from its position of equilibrium and into rotation about the bearing center at a speed corresponding to the average speed of the oil film, or approximately one-half journal speed (28). At most speeds, these film forces are balanced by the load on the journal. At twice critical speed, however, the average speed of the film and the speed of elastic shaft vibration (critical speed) coincide, making possible a resonant combination of these two forces. This is oil-film resonance.

Above twice critical speed it has been found that there is a region of stable operation which lasts until oil-film whipping begins at shortly before 3 times critical speed. Like oil-film resonance, oil-film whipping is initiated by film forces acting in co-operation with the elastic characteristics of the shaft and supporting structure. Unlike oil-film resonance, however, whipping does not decay when shaft speed is raised above 3 times critical speed, but becomes increasingly violent. It has been suggested that in this range the lubricant ceases to flow in streamlines and breaks up into eddies so that hydrodynamic action is not restored. In any event, the effect is the same—the load-carrying capacity falls to zero.

Either of the foregoing conditions of instability may be initiated by a variety of rotating forces. The initiating force may be a sustained force as in the case of shaft unbalance, skew stiffness, or rotation of the magnetic field in an electric machine. Or it may be a transient force caused by a sudden change of journal speed, gyroscopic action, or a blow on the shaft. The various conditions of transient instability have received less attention than that due to shaft unbalance. Whirling due to cramping fits has been treated by Newkirk (29), that due to internal friction by Kimball (30, 31), that due to skew stiffness by Robertson (32). Whirling due to oil-film action has been investigated by Newkirk (33) and Taylor (34), Hummel (35), Stodola (36), Robertson (37), Hagg (38), Baker (39), Burwell (40), and others.

SUMMARY

The objective of this paper has been to present a very brief survey of the progress and present state of the hydrodynamic theory of lubrication, particularly as it relates to the load-carrying capacity of journal bearings. Since comprehensive treatment of such a large subject is impossible in a short space, primary emphasis has been given to those aspects of the subject which are not treated adequately by the classical theory, or which have not yet been brought into agreement with the theory. Foremost among these aspects of the subject are the following:

1 There is as yet no single criterion for load-carrying capacity which fulfills satisfactorily the practical needs of the engineering profession.

2 There is as yet no satisfactory method of measuring or computing the variation of lubricant viscosity within the load-supporting film.

3 There is as yet no satisfactory method of measuring or computing the temperature gradient within the load-supporting film.

4 There is as yet no comprehensive evaluation of possible physical and chemical actions between lubricants and bearing materials.

5 There is as yet no comprehensive treatment of the interaction between oil-film forces and transient elastic forces and of their effect on rotating shafts.

ACKNOWLEDGMENT

The author takes pleasure in acknowledging his indebtedness to Messrs. A. F. Underwood and J. B. Bidwell of the Research Laboratories Division General Motors Corporation, and to Professors F. H. Emerson and D. L. Perkins of Wayne University for valuable criticisms and suggestions.

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(*Continued on page 326*)

What Can the Machine-Design Field Expect From the Recent College Graduate?

By C. H. YOUNG[1]

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ONE hundred and thirty-three engineering schools throughout the country are graduating over 5000 men each year and probably will continue to do so in slightly diminishing numbers until 1950, according to reports of the American Society for Engineering Education. Most of these men will be hired by industry. What kind of men are they? How well are they prepared? How will they fit into an organization? The answers to all of these questions are highly important.

WHAT CAN BE EXPECTED OF THE RECENT GRADUATE

To answer this question, we must examine the kind of education the recent graduate has been subjected to. It will be quite different from that which most of us older men received when we went to college. It would pay us, therefore, categorically to examine the kind of curriculum he has pursued.

About 15 to 20 per cent of his time has been spent on what are termed subjects of the sociohumanistic stem. And these will, in most cases, have been spread over the four years into an integrated program. In his freshman year, he will have had English composition. In place of history as such, he will spend from one to two years in the broader subject of western civilization. At least one semester of public speaking is a must in this type of setup. As now administered in most schools, this latter includes a recording of his speech with a playback so that he can recognize his deficiencies. Somewhere in the four years, he will have probably a year of social economics with either an extension into social philosophy or a seminar course in this latter subject.

When we come to the so-called technical stem, that is, the engineering part of his education, we find that this is roughly divided into three parts. For the first two years his studies are largely concerned with basic fundamentals and will include mathematics through differential equations, a rather extended course in physics, followed in most cases by mechanics and dynamics, a strong course in chemistry with some quantitative analysis and of course graphics, including engineering drawing and descriptive geometry. Starting usually in the second year of college, we find the introduction of what I like to call the engineering fundamentals; such as thermodynamics, mechanics of materials, materials-testing laboratory, electrical engineering, metallurgy, and fluid mechanics. The third phase of the technological stem is the engineering specialization, and for mechanical engineers would include heat power, power plants, internal-combustion engines, aerodynamics, kinematics, mechanical processes, and machine design. Most mechanical-engineering students get some work in such topics as engineering economy and industrial organization.

This is not to be considered a standard curriculum. The titles of the subjects will vary from school to school; as well as the allotment of time among the various subjects. Likewise, the emphasis will vary from section to section throughout the country. This has to be so, since no college knows exactly what job each student will take on graduation. He has to be prepared to step into any industry, and all specialization will have to be delayed until after he has made his first contact. However, it is a formidable array. I sometimes wonder that we do not kill him before we graduate him.

We have now a well-rounded graduate who can step into any mechanical-engineering job as a trainee. And this is just what we did when we graduated ten, twenty, thirty years ago. But he has had something that most of us lacked. The emphasis in all his learning has been on logical thinking and problem analysis. By problems, I do not mean the examples which are assigned as homework or given on tests. As Dr. Woodward says, "A problem exists whenever the answer is not self-evident." He has been taught to define his problem, to assemble and analyze the data, to devise a satisfactory method of solution, and always to check carefully the validity of his answer.

Such a man is ready to step into an organization and give a creditable performance provided the impossible is not expected of him. With proper training and further education most of them will go just as far up the ladder of success as there are openings. If the proper openings do not exist in one organization he will seek them elsewhere. This is the man you will get as raw material.

WHAT YOU CANNOT EXPECT TO FIND IN THIS YOUNG MAN

Since this message is directed principally to men interested in machine design, I will say specifically you will not get a machine designer. True, he has had some classroom experience in such work. Such experience, depending on the school, will vary all the way from a one-semester course covering both kinematics and design to as much as five semesters, with many additional hours of drawing-board work. But I am not too worried about the clock-hours he has spent on this particular subject. Rather, I am concerned with his liking for the work and his over-all ability. Consequently, he will need careful supervision and guidance for some time after he goes on the job, until he is familiar with the particular line of work of the company, its policies, and, yes, its idiosyncrasies. If you want a man who can step into a particular job in your office, hire a man with that experience. Don't hire a recent college graduate. He will be a disappointment to you, and it will be disastrous to him. I once refused a job shortly after graduation, because, during the interview, I was asked what allowable working stress I would use for a machine member. I thought I was showing how well I had studied in college when I replied, "That depends on the material and the factor of safety used, which in turn depend on a number of things." When the interviewer intimated that that was the trouble with the younger generation, they thought they knew it all, but could never answer a specific question, I got up and left. No, you won't get a man who has all the answers at his fingertips.

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[1] Chairman, Department of Machine Design and Engineering Drawing. Mem. ASME.

Contributed by the Machine Design Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

You won't even get a good draftsman. We college educators do not know which men are going into machine design, so very little emphasis is placed on delineation in most colleges. He will know the fundamentals of good drafting and should be able to make a presentable sketch. But he will need a lot of drawing-board practice. You will have to give him this experience and be patient with him. If, on the other hand, you really want a draftsman, instead of a young engineer, you would do better to look to the technical high school or the vocational school. They give many hours to good line work that we in the colleges would consider wasted time. And I might say parenthetically that I keep a list of firms to which I will not send my men because they offer no engineering future but only want draftsmen.

This man you hire will be a strange animal, full of contradictions. You cannot expect him to be mature. He is young and has had a sheltered experience. Even the veterans with their service experience tend to be one-sided and will need guidance before they can be expected to assume independent responsibility. And I say this with all due admiration for the wonderful records these veterans have made in their schooling.

The young college graduate will not measure up to your ideas of a man who can be assigned responsible charge. He will have the appearance of being overconfident, yet at heart he will be timid. He will continually want someone to lead him by the hand simply because his past experience has necessitated that most problems be rather sharply defined for him. He will be courageous, but easily discouraged, and he will be worrying continually about how he is getting on. Two things in his life during the past four years will have fostered this condition in this thinking. He has been led to expect in school that at rather frequent intervals he will receive a report on his progress, and, though we, who have been his teachers, have tried to prepare him for the change, he will still be worried because he does not frequently receive indications of his passing or failing. The other item will be the change in the passing grade. In school, 65 to 70 per cent is the generally accepted grade, and, when a student achieves a "B" or better average, he struts with pride. In industry, 100 per cent is the passing grade and naturally this will worry him. It will take time before he can adjust himself to these new conditions.

So you will not be able "to throw the book" at him and leave him to sink or swim. A little guidance, a helping hand, and a few words of encouragement will save a worth-while man from floundering in despair before he has learned to paddle for himself. I remember a number of years ago I was asked to speak to the Rotary in a small Texas city. I had just learned the conditions under which the valedictorian of the high school had been fired from his first job. He had been thrown into the job and censured when he made mistakes but never encouraged when he did right. Mentally he went to pieces; but it was not he who failed, it was his boss. And it was on this topic that I spoke to Rotarians. And it is a warning that I now give you.

Yes, this man will be very immature, but with proper care and help you will find he will develop very rapidly. We who have taught them often marvel at the sudden aging our students experience in only a few short months in industry.

So, you will not get a trained man, you will not get a man who is sure of himself, you will not get a man who can stand alone, nor will you get a man with maturity.

WHAT WILL HAVE TO BE DONE AFTER HIRING THE GRADUATE ENGINEER

We have educated him, you will have to train him. We have here a situation analogous to that in the medical profession. After the student has graduated from the medical school, he goes into the hospital for his internship. This is his training period. The first few years the engineering graduate is in industry are his intern period.

You must train him for the particular job, in this case machine design. And you must train him for advancement. This can best be done by regular visits to the shop to see the work in hand and by a variety of tasks at the board. And these should be closely tied together. Care should be taken to explain why a particular job was designed a certain way; how the manufacturing processes imposed conditions on other jobs In this way he will learn to appreciate the practical application of the things he learned in college.

It will also encourage him if he has a rather clear idea of what the future holds for him in the organization. You should take pains to outline carefully the steps ahead, give him some idea of the time it will take and what such advancement will mean to him in remuneration and prestige. He is not mercenary but just anxious. You will not have to commit yourself rigidly, but a general over-all picture will answer many of the questions that are in his mind and tend to allay his dissatisfaction over the apparent lack of rapid promotion.

You should make it clear how you expect him to prepare for such advancement. He has been taught to expect that he will have to do considerable further study. As you watch him, you can suggest the material about which he should gain a fuller knowledge. It might even be wise to make the time for such study available. In the case where graduate study leading to an advanced degree is necessary, a suitable leave of absence should be arranged. And if you are afraid he may not come back to you, then you have not done your part of the job correctly. If your organization is large enough, you should indulge in what are known as inservice courses in management, personnel problems, and special technical phases of your work.

You should also encourage him to get out and meet engineers of other companies. See that he joins the junior group of the professional societies. (And I use the plural advisedly there.) Let him know that you expect him to attend their meetings regularly and to participate in the discussions and in presenting papers. Your prestige can be enhanced in this way. Several of the best papers at one of our recent meetings were given by junior engineers, and their companies can be very proud of them. In this connection, do not be niggardly about expenses.

This is what you will have to do after you hire him. The recent engineering graduate is a tender immature plant germinated in the hothouse of the American college. See that you nourish and cultivate him.

TEN-WEEK sales training courses for salesmen of the Kellogg Division of the American Brake Shoe Company have been in operation for more than three years in Rochester, N. Y.

The course of instruction covers everything from mechanical theory through functioning and actual assembly of products. The course includes technical instruction on air compressors and paint spray equipment with general instruction on mechanical troubles and service policies.

At the beginning of the ten weeks' course of study, students are conducted on an extensive tour of the company's Rochester plant where they see firsthand how the products are produced. They are then given an opportunity to dismantle, examine, and reassemble complete air-compressor units.

Several days are devoted to classroom studies which covers selection of compressors to perform specific duties and functions, as well as the reasons for selecting the control devices required on special-purpose units. Motors and electrical control devices are discussed at great length.

To give practical supplement to the training, salesmen spend the next part of their training in the service, plant inspection, and engineering departments.

PROGRESS *in* RAILWAY MECHANICAL ENGINEERING[1]

1947-1948

ADOPTION of the Diesel-electric locomotive by the railroads continues to be the outstanding phase of motive-power development. So complete has been this acceptance, that one of the long-established domestic manufacturers of steam locomotives announced the abandonment of manufacture of this type of locomotive in its United States plant. A new builder of Diesel-electric locomotive power announced its entry into this field during the past year.

An increasing number of roads have announced plans for complete dieselization of all their services, or of important divisions of their lines. Some of the smaller roads already have reached this goal.

The Canadian lines have commenced to use Diesel-electrics in road services, but because of a fuel situation (price and supply) differing from that in the United States, these railroads are proceeding more slowly toward extensive dieselization. Manufacture of complete Diesel-electric switchers in Canada has been started, and the first all-Canadian-built switchers of types standard in the United States were delivered to Canadian roads during the year.

While a few new designs made their appearance during the year, Diesel-electric locomotive production has become standardized to the extent of quantity production of "frozen" basic designs which have been accepted by the railroads as practical, well-proved, motive-power tools. The success attained by the relatively low-powered single operating unit, operated in combinations of one to four cabs, with consequent high weight on drivers for the resultant locomotive, has discouraged any widespread development of high-horsepower single-cab locomotives. The characteristics provided by electric drive, namely, high initial tractive effort and full-horsepower utilization over a broad range of speed, play an important role in the successful application of the Diesel-electric to a wide variety of services.

Although the conventional steam locomotive seems to have been relegated to second position in so far as new motive-power orders are concerned, several requisitions for new steam power were placed by domestic railroads in the past year. As of September 1, 1948, there were 1510 Diesel-electric locomotives and 116 steam locomotives on order by the Class I Railroads of the United States. In some road-freight applications where relatively low locomotive utilization holds, the higher initial cost of the Diesel-electric cannot be justified when compared to the economy of full steam power. The so-called "coal" roads continue to acquire and to use new steam power with considerable success.

Electrification of railroads continues in many parts of the world, particularly in South America and South Africa. Extensive electrification programs are under consideration in some of the Asiatic countries, notably India and Siam, in conjunction with the development of native natural resources for the production of electric power. It is reported, although without details, that extensive electrification of some of the lines of the USSR is being undertaken.

Considerable apprehension has been expressed in some circles as to the assurance of future oil supplies for railway motive-power use, and the apparently limited supply, with an ever-increasing number of uses calling for oil, has quickened interest in the coal-using forms of motive power.

Efforts to utilize the steam turbine as a prime mover for railway motive power, principally in coal-burning units, are still being made in the United States.

Development work aimed at the utilization of the gas turbine in both the coal-burning and the oil-burning forms continues at a moderate rate. No new locomotives of this type have taken to the rails during the past year, either in the United States or abroad.

Conversion of a number of steam locomotives to utilize fuel oil for the purpose of conserving coal is reported from England, despite the existence of domestic coal and the necessity of importing the fuel oil.

STEAM LOCOMOTIVES

Fig. 1 is illustrative of a lot of ten locomotives built in the Reading Company shops for relatively light high-speed passenger-train service. Details are given in Item 1, Table 1.

The Pacific-type locomotive shown in Fig. 2, and described in Item 2, Table 1, was built by the London Midland Region shops of the British Railways and is being run in comparative tests with the 3200-hp Diesel-electric described elsewhere in this report. This steam locomotive is equipped with four cylinders, the two outside driving the intermediate pair of wheels while the inside pair, placed forward over the leading wheels of the engine truck, connect with the leading wheels by means of a built-up crank axle.

A three-cylinder 4-6-2 type locomotive shown in Fig. 3, built for the Eastern and North Eastern Regions of the British Railways, is described under Item 3, Table 1.

Information has been received during the year on Japanese railway developments which occurred during World War II. The locomotive illustrated in Fig. 4 and described in Item 4, Table 1, is one of 285 built during 1944. Fig. 5 shows a freight locomotive built for the Japanese Government Railways, 126 of which were built during 1943 and 1944. Details of this 2-8-2 type locomotive are given in Item 5, Table 1.

Fig. 6 illustrates a 36-in-gage Beyer-Garratt locomotive for the South African Railways. Upon completion of the present order for these articulated locomotives, described in Item 6, Table 1, the South African Railways will have 250 Garratt locomotives in service.

A much smaller Beyer-Garratt articulated locomotive is shown in Fig. 7. Although this type of locomotive has been in service for several years on the Nepal Government railways,

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[1] Report of Committee RR-6, Survey; chairman, T. F. Perkinson; members, F. L. Murphy, E. L. Battley, Fred Benger, R. P. Johnson, H. C. Wilcox.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

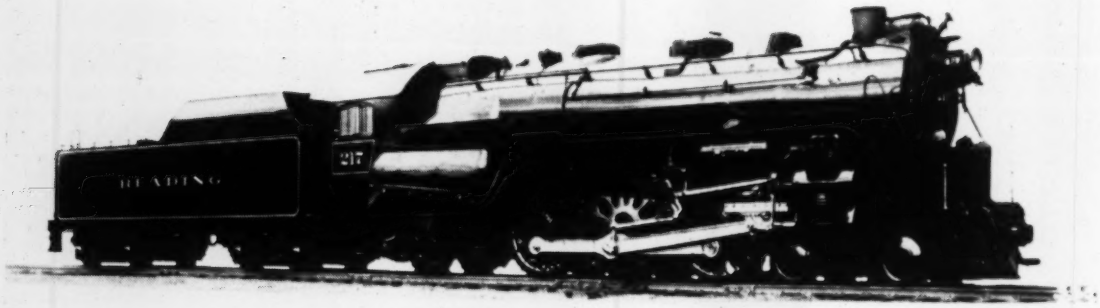

FIG. 1 PACIFIC PASSENGER LOCOMOTIVE FOR THE READING COMPANY

FIG. 2 FOUR-CYLINDER PASSENGER LOCOMOTIVE FOR BRITISH RAILWAYS

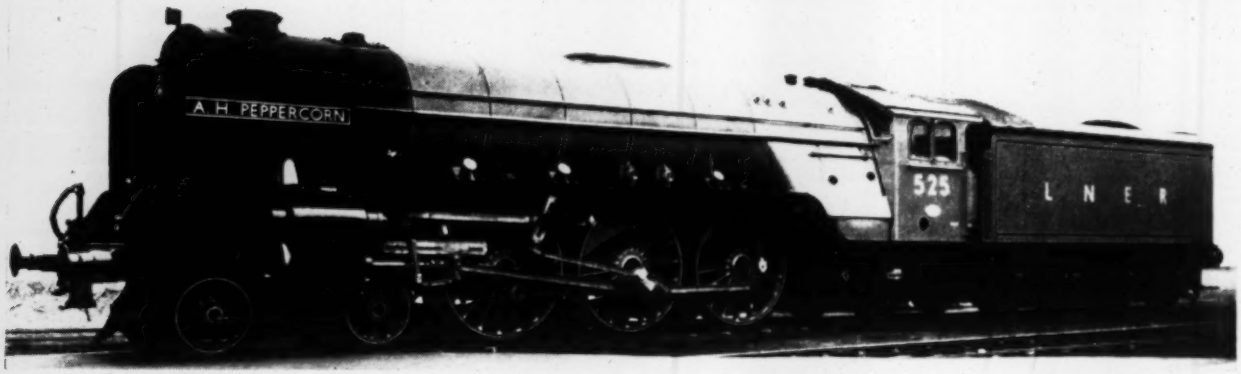

FIG. 3 THREE-CYLINDER LOCOMOTIVE FOR BRITISH RAILWAYS

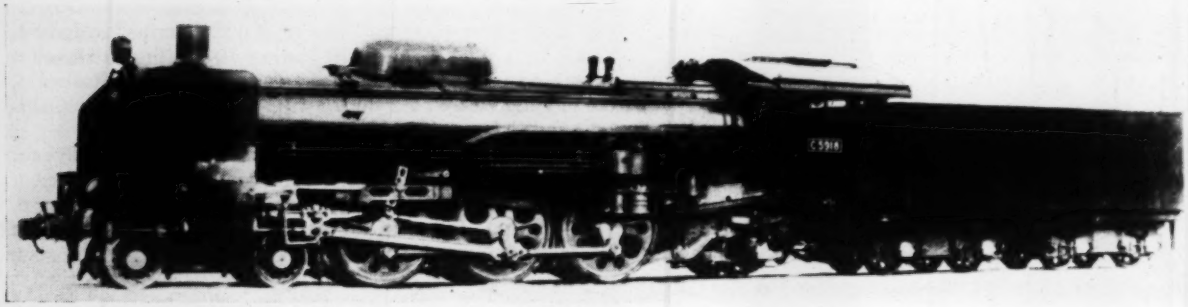

FIG. 4 PASSENGER LOCOMOTIVE BUILT IN JAPAN DURING WORLD WAR II

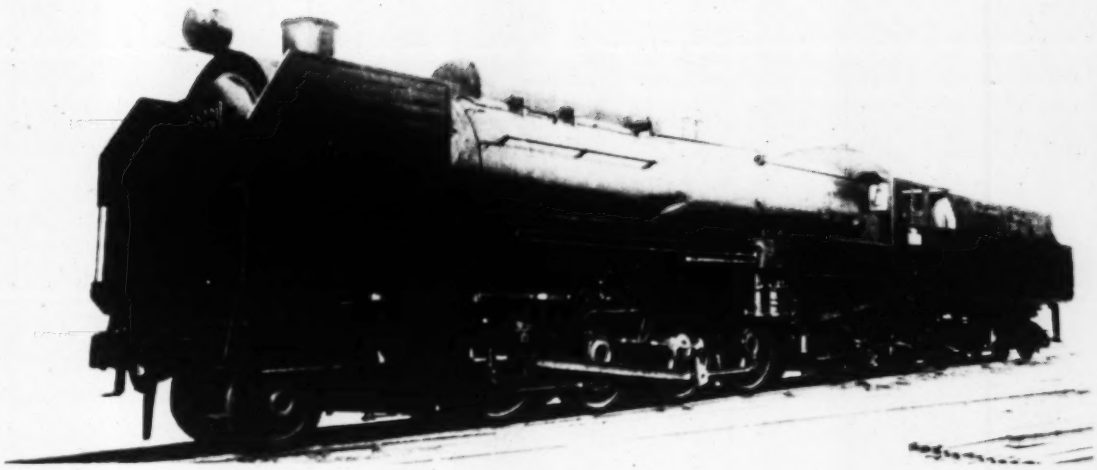

FIG. 5 2-8-2 TYPE FREIGHT LOCOMOTIVE FOR JAPAN

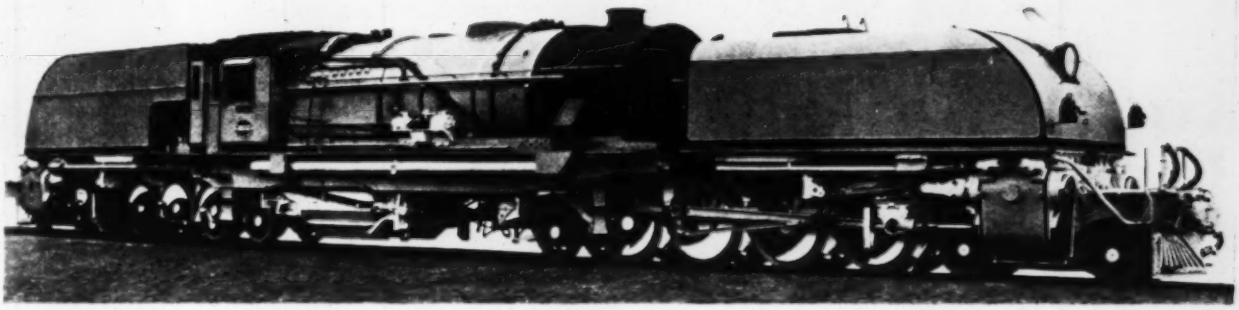

FIG. 6 ARTICULATED LOCOMOTIVE FOR SOUTH AFRICAN RAILWAYS

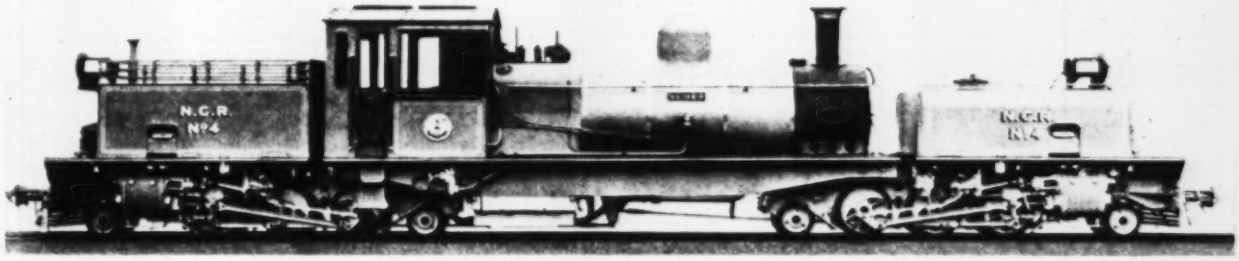

FIG. 7 30-INCH-GAGE ARTICULATED LOCOMOTIVE FOR NEPAL

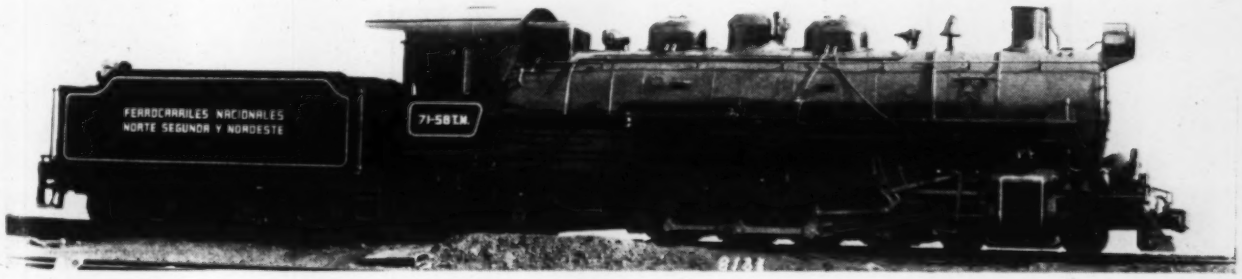

FIG. 8 AMERICAN-BUILT FREIGHT LOCOMOTIVE FOR COLOMBIA

TABLE 1 CHARACTERISTICS OF STEAM LOCOMOTIVES

Item	Builder	Owner	Wheel arrangement	Service[d]	Cylinders No.	Cylinders Diam	Cylinders Stroke	Boiler pressure	Driver diam	Weight on drivers	Total locomotive weight running order	Heating surfaces Evaporative	Heating surfaces Superheater	Heating surfaces Total	Grate area	Track gage	Tender Wheels	Tender Fuel, tons	Tender Water	Tender Weight w/ loaded
1	Reading	Reading	4-6-2	P	2	25	28	260	80	197200	329500	2983	770	3753	95	56½	8	19	12500	211000
2	British Rwys	British Rwys[a]	4-6-2	P	4	16½	28	250	81	152500	238300	2807	979	3786	50	56½	6	11	4800	107100
3	British Rwys	British Rwys[b]	4-6-2	P-F	3	19	26	250	74	147800	226500	2461	679	3140	50	56½	8	10	5000	114500
4	Japan	Japan Rwys	4-6-2	P	2	20½	26	228	69	107100	176900	1992	765	2757	35	42	8	11	6610	98100
5	Japan	Japan Rwys	2-8-2	F	2	21⅝	26	228	55	143300	187400	1951	833	2784	41	42	8	13	6600	91600
6	British[c]	South African Rwys	4-8-2 + 2-8-4	F	4	18½	26	200	48	230000	369000	2540	463	3003	51	36	"	10	5650	"
7	British[e]	Nepal Gov't Rwys	2-6-2 + 2-6-2	F	4	10	16	175	28	67900	106400	648	120	768	77	30	"	3	1300	"
8	H. K. Porter	Colombia[f]	4-8-2	F	2	18½	22	210	42	190500	128000	2497	685	3182	48	36[g]	8	8[h]	4000	68000

[a] London Midland Region.
[b] Eastern & North Eastern Regions.
[c] Beyer, Peacock & Co., Ltd.
[d] P = Passenger, F = Freight.
[e] Beyer-Garratt-type locomotive—tender and locomotive combined.
[f] Consejo de Ferrocarriles, Bogota, Colombia, S. A.
[g] Changeable from 36 in. to 39⅜ in. gage.
[h] Tender also built for 2000 gal of fuel oil in lieu of 8 tons of coal.

NOTE: Cylinders, driver diameters, and track gages expressed in inches. Boiler pressures expressed in pounds per square inch. Weights expressed in pounds. Heating surface and grate areas expressed in square inches.

an additional order for these 30-in-gage locomotives is now being shipped to the Nepalese Government. Details are given in Item 7, Table 1.

Fig. 8 shows an American-built locomotive, seven of which have been shipped to Colombia. Characteristics of these freight locomotives are given in Item 8, Table 1.

The report for 1947 included mention of an experimental semiautomatic steam switching locomotive converted by the Norfolk & Western Railway. The railway reports generally satisfactory operation of the unit and has under conversion another similar switcher. A year of operation has indicated the necessity for special steel for the induced-draft-fan blades to provide satisfactory life of blading against the abrasive action of cinders. Cinder collection has been another problem. The new unit will utilize a centrifugal cleaner for removing cinders from the exhaust gases.

ELECTRIC LOCOMOTIVES

A new design of motor-generator locomotive by General Electric in a double-cab arrangement, Fig. 9, with locomotive weight of a million pounds on drivers was placed in service on the electrified section of the Virginian Railway. Each of the two cabs composing the locomotive contains a 4000-hp five-unit synchronous-motor generator set, with a resultant wheel-horsepower rating of 6800 for the two-cab locomotive. Continuous tractive effort of 162,000 lb at a speed of 15.75 mph is available. Power is taken from an 11,000-volt, 25-cycle single-phase overhead contact system. Details are given in Item 1, Table 2.

Built for service on a 60-in-gage system, the 3300-volt d-c locomotive shown in Fig. 10 is believed to be the largest and most powerful single-cab direct-current electric locomotive built to date. Intended for freight service, the locomotive is rated on 3300 volts at 5550 hp continuously and 5860 hp for 1 hr. The over-all length is 90 ft, and the total weight in running order is approximately 272 tons. Characteristics are given in Item 2, Table 2.

Fig. 11 shows a 3000-volt main-line haulage unit equipped for regenerative braking. Details are given in Item 3, Table 2.

Fig. 12 illustrates a 42-in-gage 1500-volt d-c locomotive built in Japan in 1944, for the Japanese Government lines. Item 4, Table 2, gives the descriptive data of this locomotive.

A 1500-volt d-c mixed-service unit built in Switzerland for the Netherlands Railways is shown in Fig. 13, and described in Item 5, Table 2. The continuous rating of 3615 hp (4255 hp for 1 hr) is secured from eight frame-mounted motors, with each axle driven by two motors through reach gearing as shown in Fig. 14. The locomotives are designed for a top speed of 99.5 mph.

A meter-gage single-phase electric locomotive built for the Rhaetian Railway in Switzerland is shown in Fig. 15. The locomotive, described in Item 6, Table 2, is rated at 1580 hp (1 hr) and 1360 hp continuously.

DIESEL-ELECTRIC LOCOMOTIVES

Baldwin Locomotive Works has added to its line of Diesel-electrics a 2000-hp two-engine design on an A1A-A1A wheel arrangement. The use of two 1000-hp engines of the six-cylinder in-line type results in an over-all length of 80 ft and a general design quite similar to two-engine 2000-hp units which have been in service on American lines for the past several years. Salient features on a 6000-hp locomotive composed of two "A" units and one "B" unit of the new design are given under Item 1, Table 3, and the locomotive is illustrated in Fig. 16.

Another 1500-hp road switcher, built by Baldwin, is shown in Fig. 17, and described in Item 2, Table 3.

TABLE 2 CHARACTERISTICS OF ELECTRIC LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
Owner	VGN[a]	Export	Kennecott[c]	Japanese	Netherlands	Swiss[g]
Builder, mechanical	GE[b]	GE[b]	GE[b]	Japan	Swiss[d]	Swiss[d]
Builder, electrical	GE	GE	GE	Japan	Swiss[e]	Swiss[h]
Wheel arrangement	2(B-B + B-B)	2-D + D-2	B + B	1-C + C-1	1A-B-A1	B-B
Service (pass., freight, switching)	F	F	Sw	F	P-F	P
Power supply	11000 v, a-c	3300 v, d-c	3000 v, d-c	1500 v, d-c	1500 v, d-c	10,500 v, a-c
Current collector	Pantograph	Pantograph	Pantograph	Pantograph	Pantograph	Pantograph
No. units per locomotive	2	1	1	1	1	1
Driving wheels:						
Number	32	16	8	12	8	8
Diameter, in.	42	47 1/4	50	49 3/16	61	42
Weight, lb:						
Total	1033800	545600	250000	234000	220500	103600
On drivers	1033800	405600	250000	219000	158900	103600
Per driving axle	64500	50700	62500	36500	39700	25900
Locomotive dimensions:						
Length over-all, ft-in.	150-8	90-0	44-0	57-4	53-2 9/16	39-8 1/2
Width, over-all, ft-in.	11-1	10-0	10-6	.....	9-9 9/16	8-10 1/4
Height, pantograph down, ft-in.	16-3	14-5	18-6	9-2	15-2 7/8	.....
Rigid wheel base, ft-in.	9-0	7-2	9-0	.....	7-3 3/16	8-2 1/2
Total wheel base, ft-in.	133-10	77-2	29-0	.....	39-0 1/8	28-6 1/2
Traction motors:						
Number	16	8	4	6	8	4
Method of mounting	Axle suspended	Axle suspended	Nose and spring axle	.....	[f]	Axle suspended
Method of drive	Single reduction	Single reduction	Single reduction spur	.....	Double reduction	Single gear
Gear ratio	70/17	80/21	82/15	.....	3.56	87/16
Tractive force, lb:						
One-hour rating	.....	79500	.....	33220	25100	19500
Per cent adhesion	.....	19.5	.....	.....	15.8	18.8
Continuous rating	162000	74000	45200	.....	20200	15160
Per cent adhesion	15.7	18.2	18.0	.....	12.7	14.6
Horsepower:						
One-hour rating	.....	5860	.....	.....	4255	1580
Continuous rating	6800	5550	3110	.....	3615	1360
Speed, mph:						
One-hour rating	.....	27.7	.....	.....	63.5	29.4
Continuous rating	15.75	28.2	25.8	.....	66.5	31.7
Maximum speed, mph	50	68.5	40	.....	99.5	47
Equipped for:						
Regeneration	Yes	Yes	Yes	.....	No	Yes
Multiple-unit operation	No	Yes	Yes	.....	Yes	Yes
Track gage, in.	56 1/2	60	56 1/2	42	56 1/2	39 3/8

[a] Virginian Railway Company
[b] General Electric Company.
[c] Utah Copper Division, Kennecott Copper Corporation.
[d] Swiss Locomotive & Machine Works, Winterthur.
[e] Ateliers de Construction Oerlikon.
[f] On head frame over wheels.
[g] Rhaetian Railway.
[h] Brown Boveri Corporation; Ateliers de Construction Oerlikon.

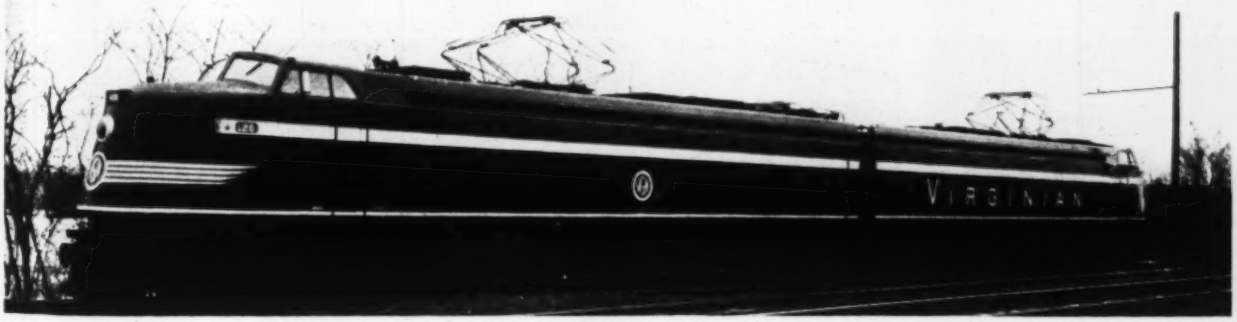

FIG. 9 6800-CONTINUOUS-HORSEPOWER LOCOMOTIVE FOR VIRGINIAN RAILWAY

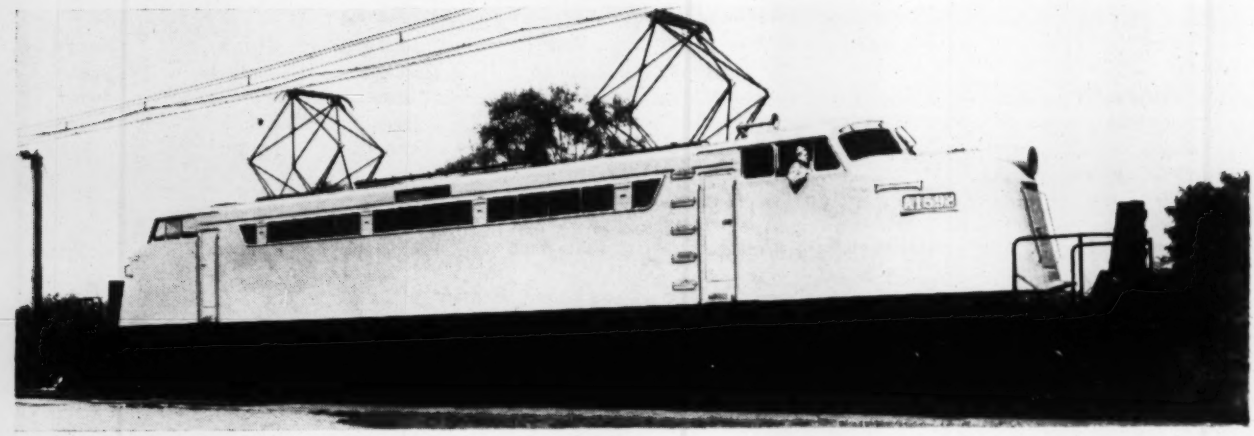

FIG. 10 3300-VOLT D-C 5550-HP ELECTRIC LOCOMOTIVE

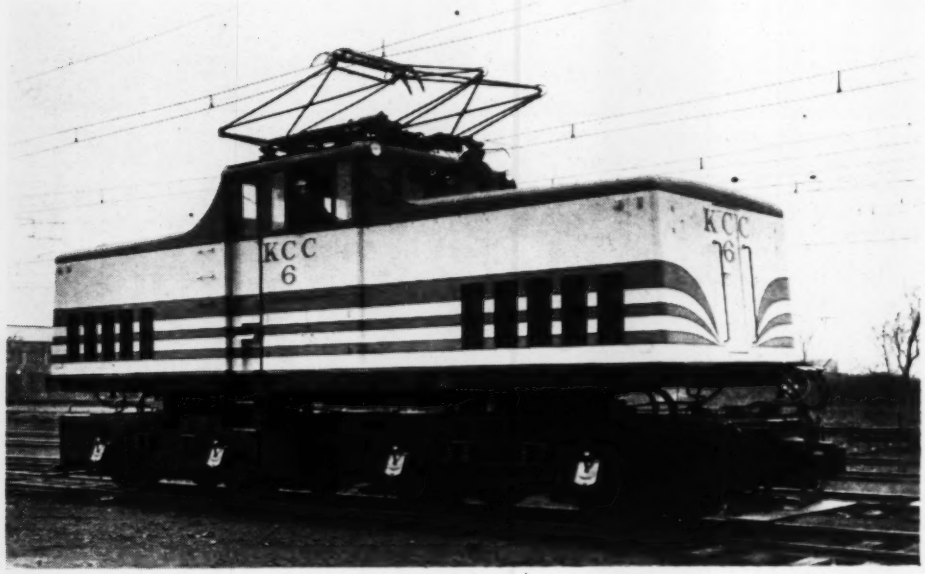

FIG. 11 3100-HP RAILROAD-TYPE SWITCHING LOCOMOTIVE

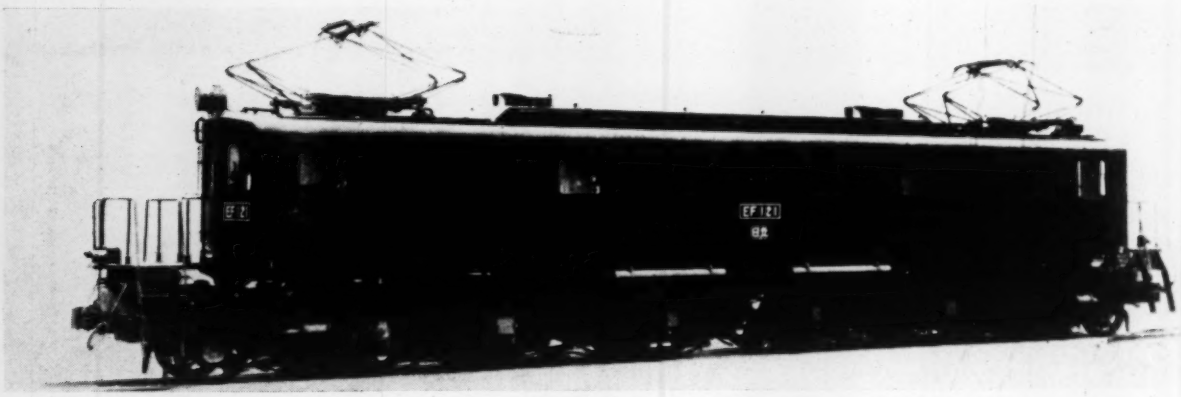

FIG. 12 1500-VOLT D-C LOCOMOTIVE BUILT IN JAPAN DURING WORLD WAR II

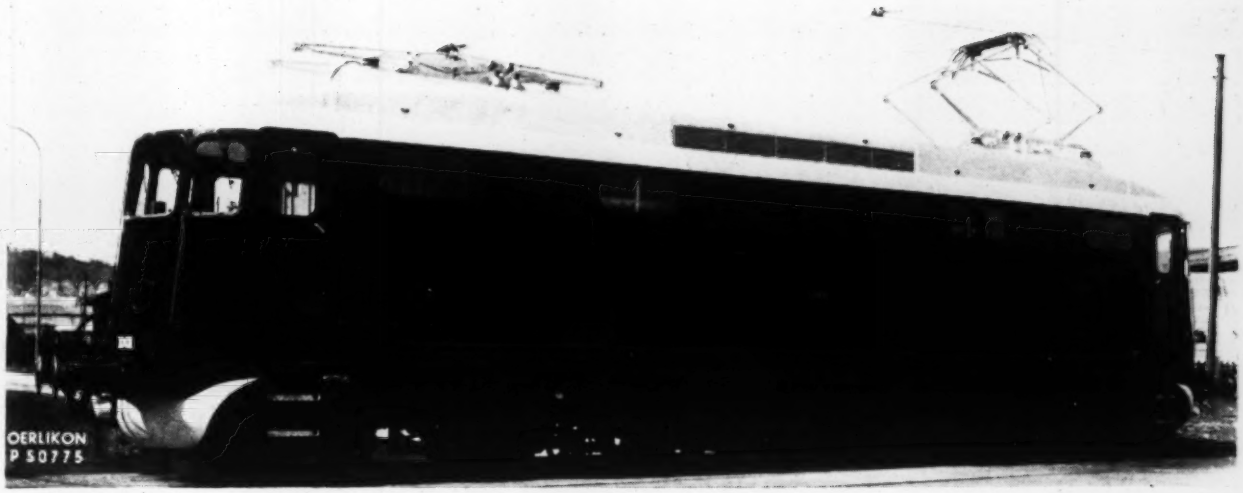

FIG. 13 HIGH-SPEED SWISS-BUILT LOCOMOTIVE FOR THE NETHERLANDS

The first large-power road Diesel-electric for service in England was produced in late 1947 for passenger service on the London Midland Region of the British Railways. The design consists of a two-cab arrangement with each cab mounted on two three-axle (all motored) swivel trucks and carrying a 1600-hp engine (Fig. 18). The method of supporting the cab on the trucks is unusual. The cab weight is taken on four loading pads in each truck, located on the spring-borne bolster members, while truck-swiveling action is secured by means of a nonweight-bearing centering arrangement. The equivalent of floating-bolster action is secured in the construction of the truck and cab supporting provisions. Tests with the steam locomotive shown in Fig. 2 are being conducted to determine the comparative economics of the two forms of power in British railway service. Descriptive details concerning the Diesel-electric are given in Item 3, Table 3.

The locomotive shown in Fig. 19 was built by the Electro-Motive Division of General Motors. Described in Item 4, Table 3, it can be used as a branch-line and road-switcher unit. The engine and electrical equipment are the same as those used on the 1500-hp road units built by the same manufacturer. A feature of this locomotive is the specially designed cab intended to give good visibility in either direction. The running board extending along the engine compartment slopes downward to permit downward visibility. Space is provided for the optional installation of a 1600-lb per hr train-heating boiler and a 600-gal tank for train-heat water.

Fig. 20 and Item 5, Table 3, illustrate and describe a motive-power unit with revenue space, built in the shops of the Milwaukee Railroad. The unit is a modernized version of the internal-combustion-engine rail cars, several hundred of which were built in the decade 1920–1930, principally for branch-line and feeder service on many American railroads. A baggage compartment 45 ft $4\frac{1}{2}$ in. in length, which includes a crew washroom, is provided in the power unit. A 1600-lb per hr boiler for train heating is provided. The unit is intended to handle four or five pieces of passenger equipment in branch-line service.

GAS-TURBINE-ELECTRIC LOCOMOTIVES

Development and construction continue on a number of gas-turbine-electric locomotives, some to burn oil, others to use coal as fuel. While none of the locomotives has been completed (in the U. S. A.), one of the several turbine-compressor power plants destined for locomotive use has been completed and

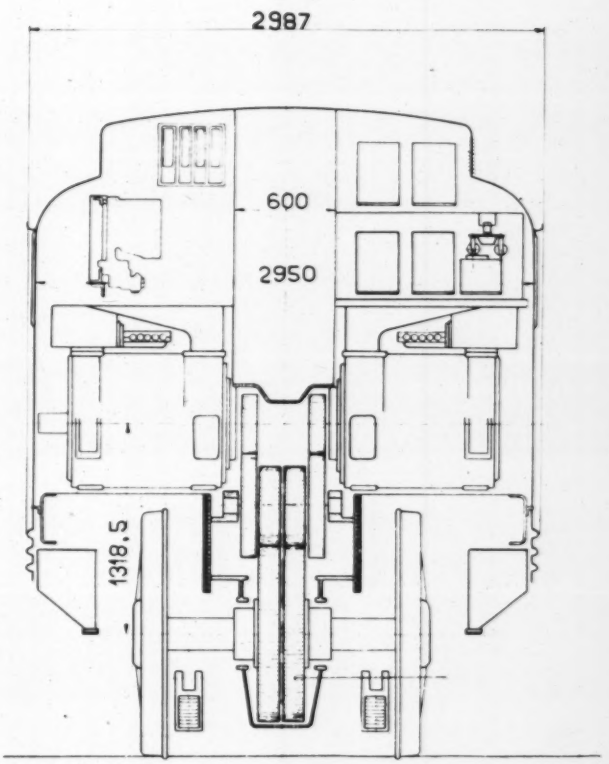

FIG. 14 CROSS SECTION SHOWING DRIVE ARRANGEMENT ON NETHERLANDS LOCOMOTIVE

run on the test stand. Fig. 21 shows a cross section through the 4800-hp turbine-compressor unit built by General Electric for subsequent application to a 4500-hp oil-burning locomotive.[2] An Allis-Chalmers 4100-hp power plant[3] for eventual inclusion in a coal-burning locomotive is shown in section in Fig. 22. A

[2] "Design Features of a 4800-Hp Locomotive Gas-Turbine Power Plant," by Alan Howard, MECHANICAL ENGINEERING, vol. 70, April, 1948, pp. 301–306.

[3] "Construction of Gas Turbine for Locomotive Power Plant," by W. B. Tucker, MECHANICAL ENGINEERING, vol. 70, November, 1948, pp. 877–882.

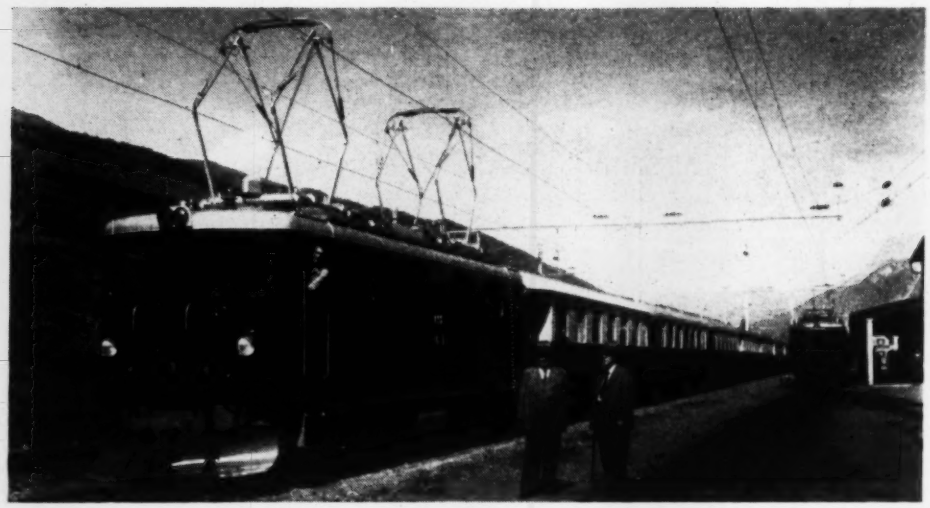

FIG. 15 METER-GAGE LOCOMOTIVE FOR SWITZERLAND

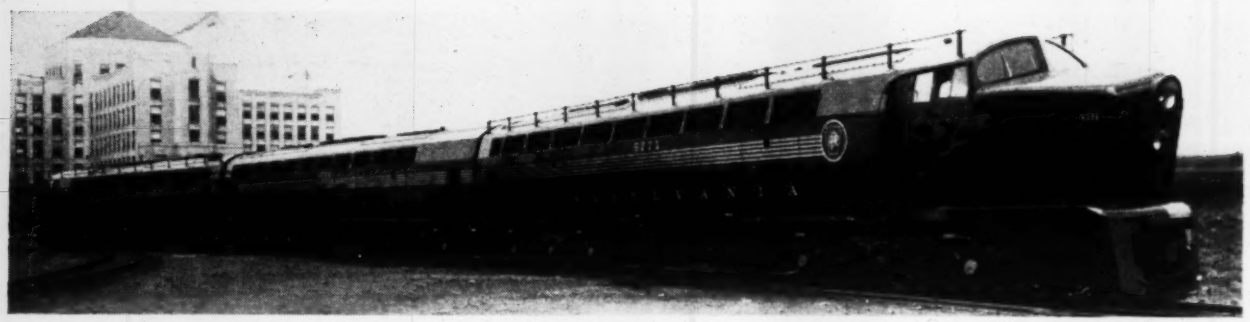

FIG. 16 6000-HP DIESEL-ELECTRIC LOCOMOTIVE FOR PENNSYLVANIA RAILROAD

TABLE 3 CHARACTERISTICS OF DIESEL-ELECTRIC LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5
Builder	BLW[a]	BLW[a]	British[d]	GMC[g]	CMS+P & P[i]
Owner	PRR[b]	WM[c]	British	CIL[h]	CMS+P & P[i]
Wheel arrangement	3(A1A-A1A)	B-B	2(C-C)	B-B	A1A-3
No. of units per locomotive	3	1	2	1	1
Total locomotive horsepower	6000	1500	3200	1500	1000
Service (passenger, freight, road switching)	P	Rd Sw	P	Rd Sw	P
Engine data (per unit):					
No. of engines	2	1	1	1	1
Horsepower (per engine)	1000	1500	1600	1500	1000
No. of cylinders (per engine)	6	8	16[e]	16[e]	12[e]
Bore and stroke, in.	$12^3/_4 \times 15^1/_2$	$12^3/_4 \times 15^1/_2$	10×12	$8^1/_2 \times 10$	$8^1/_2 \times 10$
Speed, rpm	625	625	750	800	800
Cycles	4	4	4	2	2
Supercharged	Yes	Yes	Yes	No	No
Manufacturer	BLW[a]	BLW[a]	British[f]	GMC[g]	GMC[g]
Locomotive length over-all, ft-in.	238-$2^1/_2$	58-0	122-4	57-$10^1/_2$	85-3
Rigid wheel base, ft-in.	15-6	9-10	15-8	9-0	11-0
Total wheel base (per unit), ft-in.	61-$9^1/_2$	42-1	51-2	44-0	70-6
Weight on drivers, lb	750000	240000	543000	207000	93800
Total locomotive weight, lb	1125000	240000	543000	207000	221700
Fuel capacity, total gallons	3600	900	2474	1200	1000
Driving-wheel diameter, in.	42	42	42	40	36
Track gage, in.	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$
Maximum permissible speed, mph	100	65	..	65	75

[a] Baldwin Locomotive Works.
[b] Pennsylvania Railroad.
[c] Western Maryland Railway.
[d] London Midland Region, British Railways.
[e] "V" type engine.
[f] English Electric Company, Ltd.
[g] Electro-Motive Division, General Motors Corporation.
[h] Chicago, Indianapolis & Louisville Railway.
[i] Chicago, Milwaukee, St. Paul & Pacific Railway.

FIG. 17 1500-HP ROAD SWITCHER FOR WESTERN MARYLAND RAILWAY

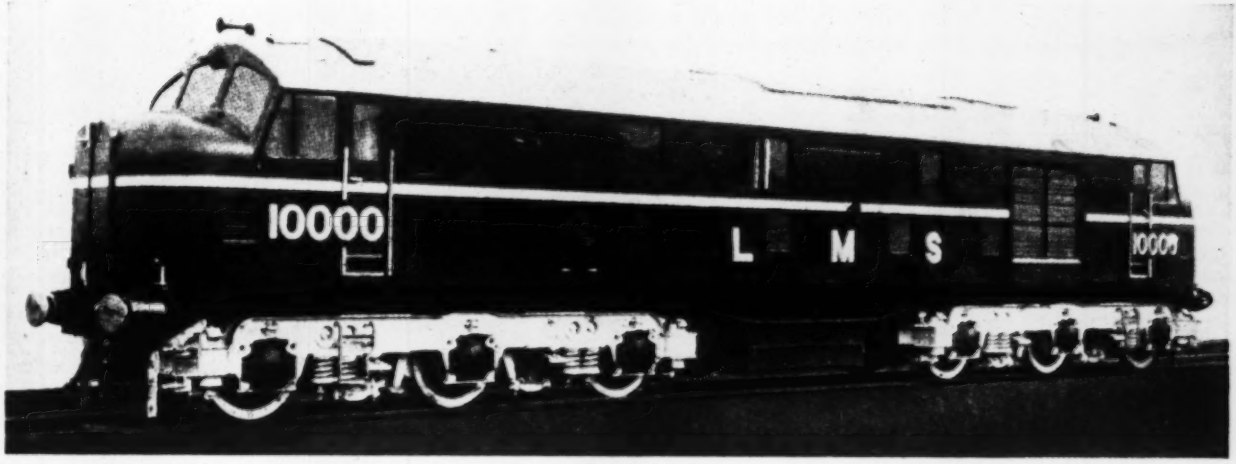

FIG. 18 BRITISH-BUILT DIESEL-ELECTRIC LOCOMOTIVE FOR BRITISH RAILWAYS

FIG. 19 1500-HP ROAD SWITCHER FOR THE MONON

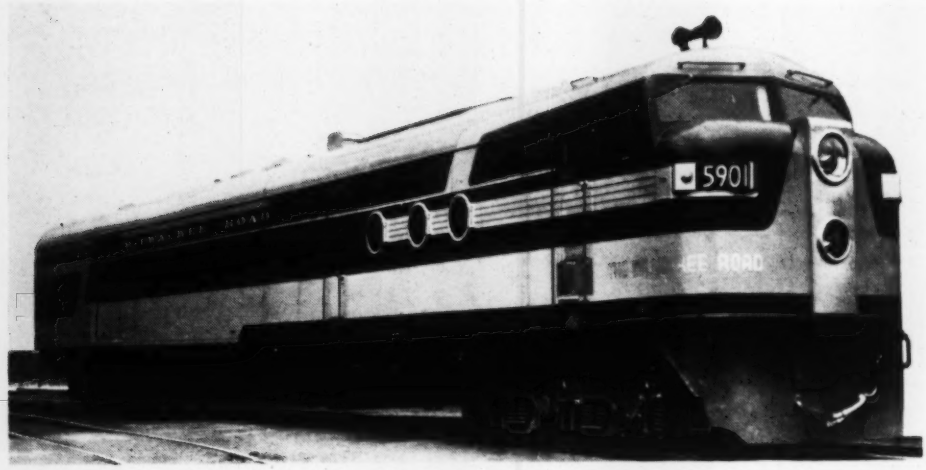

FIG. 20 DIESEL-ELECTRIC POWER RAIL CAR FOR MILWAUKEE ROAD

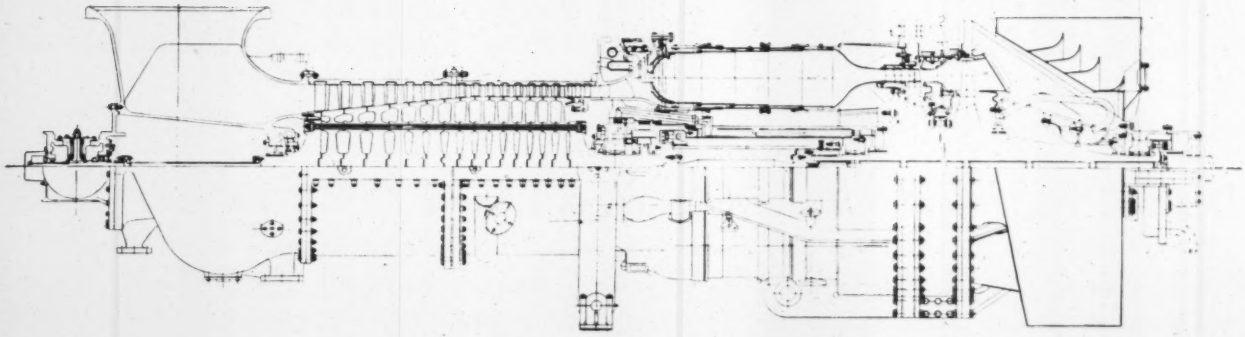

FIG. 21 GENERAL-ELECTRIC GAS TURBINE FOR 4800-HP LOCOMOTIVE

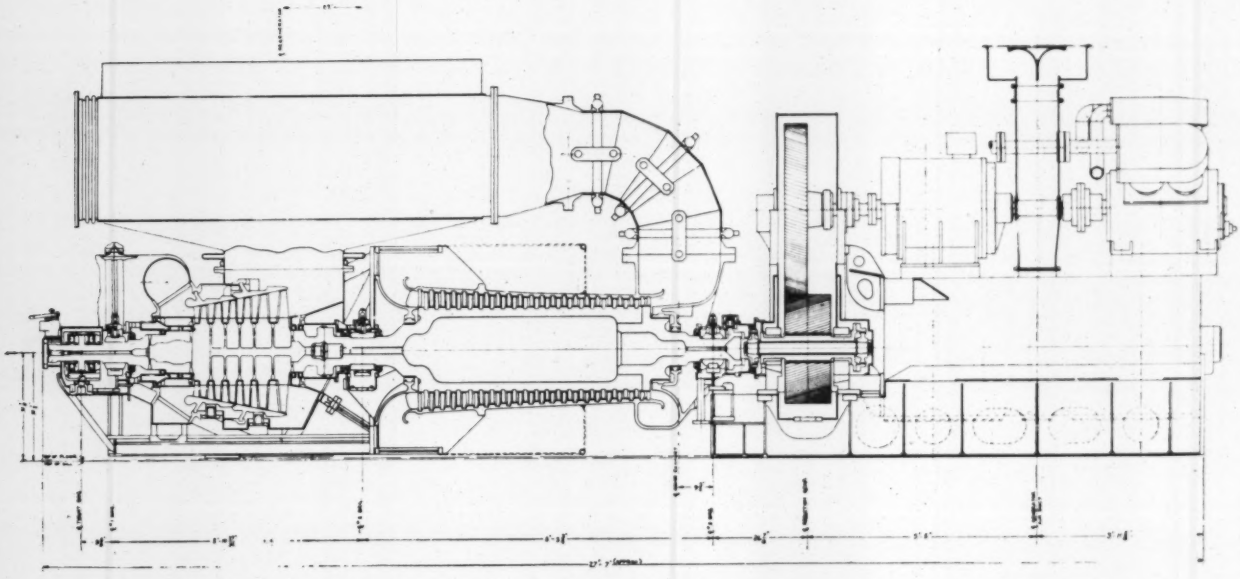

FIG. 22 ALLIS-CHALMERS LOCOMOTIVE GAS TURBINE

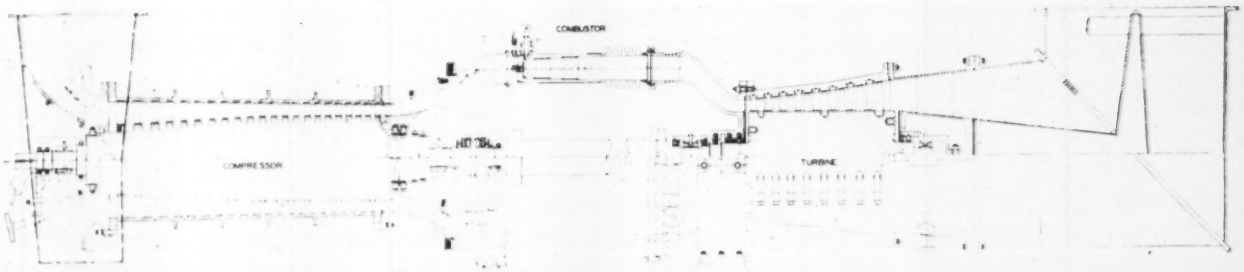

FIG. 23 LOCOMOTIVE GAS TURBINE BUILT BY WESTINGHOUSE

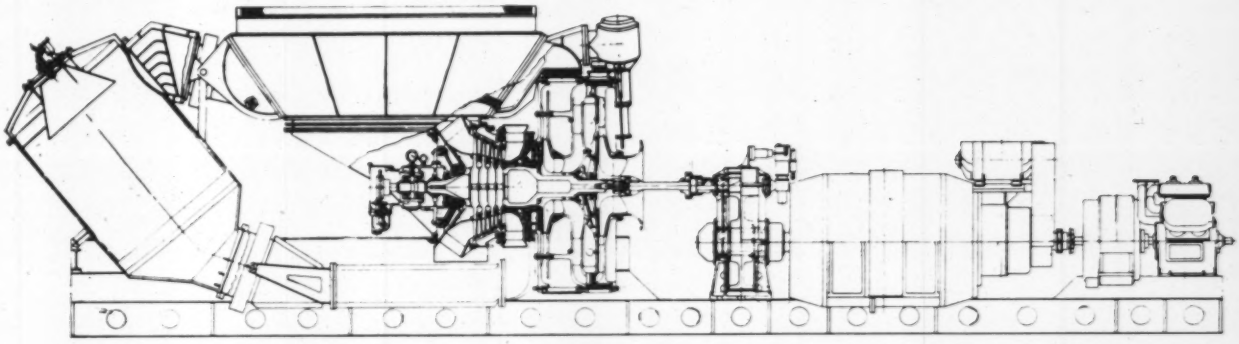

FIG. 24 ELLIOTT LOCOMOTIVE-GAS-TURBINE GENERATOR SET

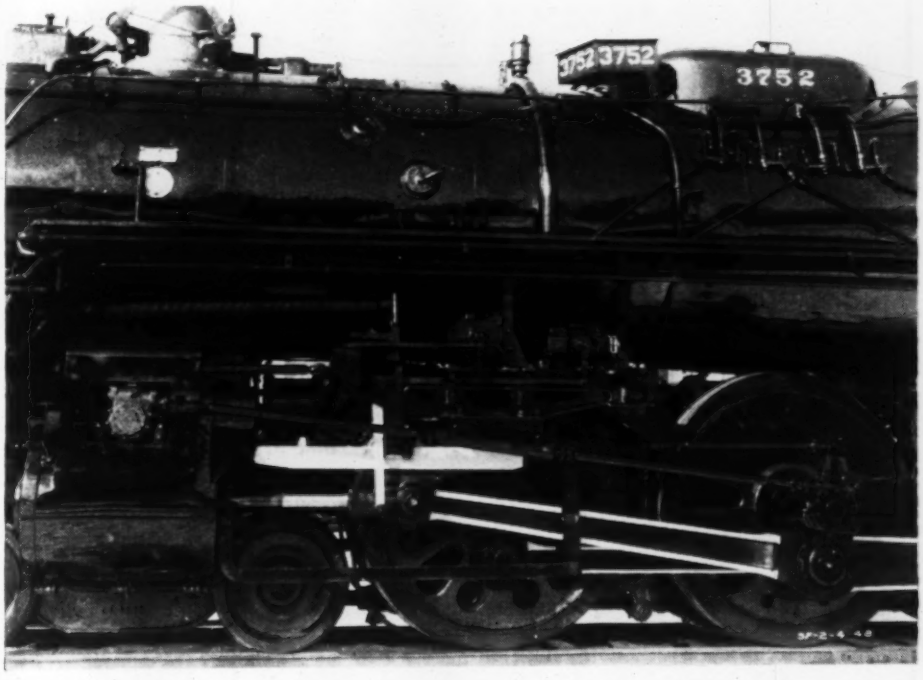

FIG. 25 POPPET-VALVE APPLICATION ON SANTA FE LOCOMOTIVE

Westinghouse 2000-hp oil-burning unit is shown in Fig. 23. All of the foregoing units employ compressors of the multi-stage axial-flow type. Fig. 24 depicts a 3750-hp unit embodying a centrifugal compressor built by the Elliott Company for application in both coal and oil-burning motive power.

STEAM-TURBINE LOCOMOTIVES

The Pennsylvania Railroad's Class S2 locomotive No. 6200, which was illustrated and described in the 1944–1945 report,[4]

[4] "Progress in Railway Mechanical Engineering, 1944–1945," MECHANICAL ENGINEERING, vol. 68, February, 1946, pp. 107–122.

FIG. 26 CANADIAN NATIONAL SNOW MELTER

FIG. 27 COACH-LOUNGE CAR BUILT BY BUDD

continues to operate in high-speed passenger service on the Fort Wayne Division between Crestline, Ohio, and Chicago. The performance is reported as generally satisfactory, although the stay bolts in the firebox have given more than usual trouble from leaking and breakage. Some engineers feel that there may be a connnection between the stay-bolt trouble and the heavy drains made on the boiler by the forward turbine at starting, but others believe the water legs and space between the combustion chamber and barrel should be "freed up," and these changes will be made when the locomotive is taken in for heavy repairs. The locomotive has made as much as 9504 miles in a single month which is considered good availability for a single operating division.

Road testing of the steam-turbine electric locomotive built by Baldwin and Westinghouse for the C&O Railway (and described in this committee's report for 1947[5]) continues. Adjustments to front-end drafting equipment and alterations to ashpan construction to facilitate combustion-air entry have been made.

MISCELLANEOUS DEVELOPMENTS

Fig. 25 shows the application of the Type B poppet-valve system made by the Franklin Railway Supply Company to a Santa Fe 4-8-4 during the past year.

A snow-melting machine developed for use on the Canadian National Railway is shown in Fig. 26. Snow is collected by the front unit and delivered by means of a pair of apron conveyers to the hopper on the melting tank. The water in the

[5] "Progress in Railway Mechanical Engineering, 1946–1947," MECHANICAL ENGINEERING, vol. 70, 1948, pp. 321–335.

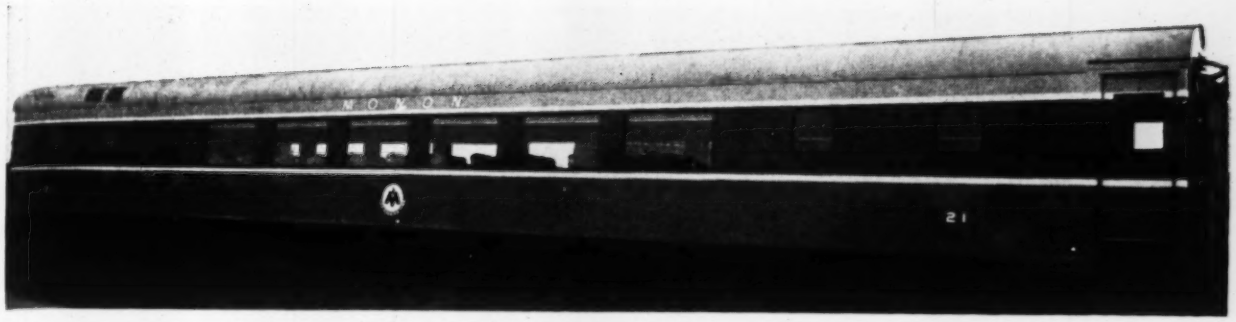

FIG. 28 MONON COACH AFTER CONVERSION FROM HOSPITAL CAR

FIG. 29 INTERIOR OF HOSPITAL CAR AFTER CONVERSION TO COACH

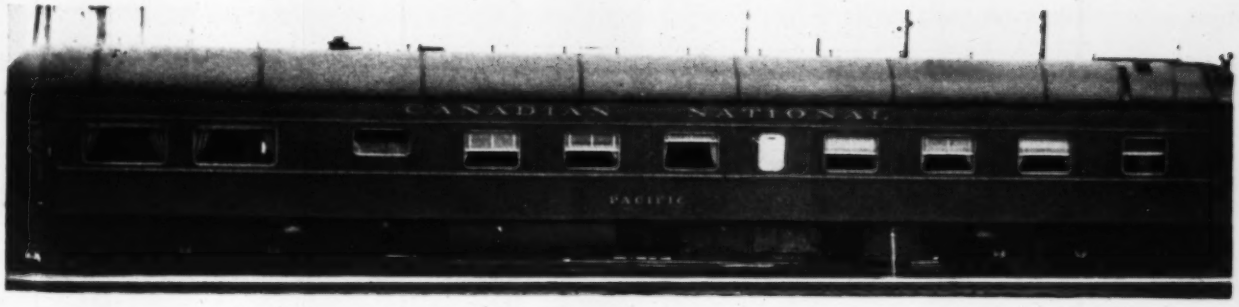

FIG. 30 PRIVATE CAR BUILT BY CANADIAN NATIONAL RAILWAY

melting tank is kept at a temperature sufficiently higher than the melting point of snow to insure rapid melting of the snow. There are two separate tanks on the melting unit. The larger tank (ahead of the cab) has a capacity of 12,000 gal and the smaller 4500 gal. Inside the cab of the second unit a gasoline-engine-driven centrifugal pump of 30,000-gph capacity provides rapid circulation of water from the smaller tank to the front end of the larger tank to disperse any collection of slush from that part of the tank underneath the snow hopper. Steam furnished from the train locomotive enters the larger melting tank through 14 jets which are regulated to maintain the required water temperature for efficient snow meltage.

PASSENGER CARS

During the year the New York, New Haven and Hartford Railroad took delivery of 103 new coaches from the Worcester Plant of Pullman-Standard Car Manufacturing Company. These cars were designed for high-speed, high-capacity, short-run day service, and some will be operated in joint service with the Pennsylvania Railroad between Boston and Washington.

FIG. 31 "LOOKOUT LOUNGE" ON NEW TWENTIETH CENTURY LIMITED

FIG. 32 FULL-LENGTH DINING CAR FOR NEW YORK CENTRAL

FIG. 33 BARBER-SECRETARY-LOUNGE CAR FOR 20th CENTURY

The trucks of these stainless-steel cars feature outside swing hangers whereby the body weight is supported directly on coil springs suspended from the outside of the truck frame rather than inside the frame as in conventional trucks.

The Budd Company has delivered a new-type coach-lounge car to the Chesapeake and Ohio Railway. The main section of this car has "Sleepy Hollow" seats, while the lounge section provides eight movable armchairs as illustrated in Fig. 27. At the end opposite the lounge section there is an alcove with a floating-top writing desk. Electropneumatic engines open the sliding doors at either end of the car. In addition to the public-address system with which the car is equipped, each coach seat contains a speaker which is built into the upper corner of the back cushion. A selector knob is located in the arm rest.

Some of the U. S. Army hospital cars built during the war and described in the report of this Committee in 1945,[4] have been declared war surplus. During the year the Monon purchased 28 of these cars to rebuild into passenger cars in its own shops. A skirt, 3 in. wide, was welded to the entire length of each side to give the cars a deeper appearance as illustrated in Fig. 28. Windows were changed, and the side doors required by the Army were removed from both sides of the cars. The first cars to be remodeled included three coaches (see Fig. 29), a combination dining-bar-lounge car, a parlor car, and a mail-baggage car. Except for additional air diffusers, ceilings

FIG. 34 PULLMAN-BUILT "EL FIESTA" DINING CAR FOR ROCK ISLAND

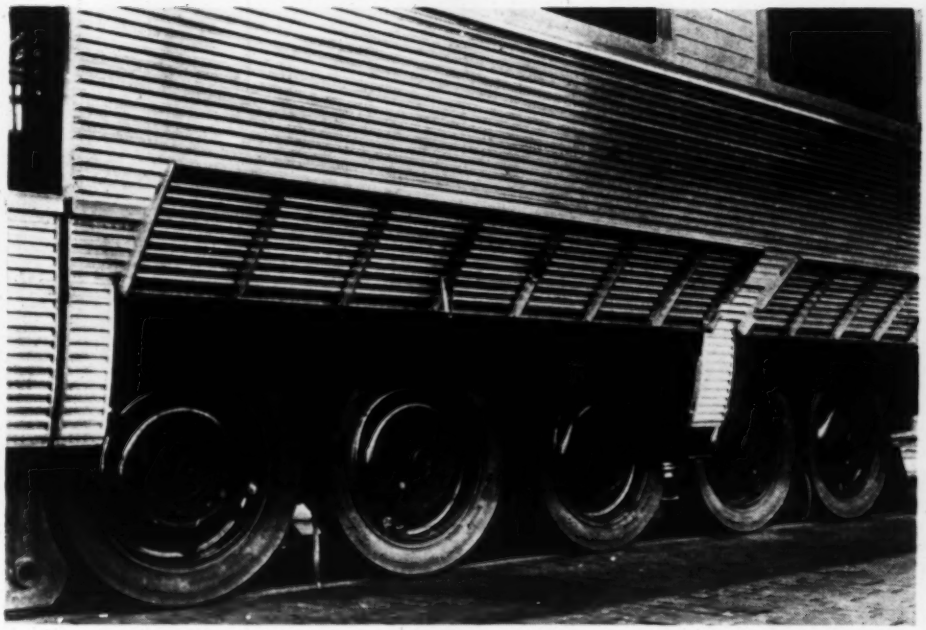

FIG. 35 10-WHEEL, RUBBER-TIRED TRUCK ON FRENCH LIGHTWEIGHT CAR

were left intact in the coaches. A low false ceiling was installed in the dining and parlor cars. Additional features were added to make these cars completely modern and attractive.

During the year several "dome-type" cars have been delivered to the domestic railroads. Among these is a new type car which was delivered to the C&O Railway by the Budd Company. Similar to the dome cars described in the report of this Committee last year,[5] the C&O car provides drawing-room and cabin accommodations. At one end of the car there are three daytime drawing rooms, each seating five passengers, and so arranged that they can be made into one large room. At the opposite end of the car there are five cabins. The elevated section underneath the glass dome in the top of the car contains 24 seats. Underneath the elevated section is a telephone booth, telephone switchboard, conductor's and radio compartments.

Built by the Canadian National Railways, the private car shown in Fig. 30 contains a combination observation-lounge and dining room, six double bedrooms, and sleeping quarters for attendants. An auxiliary power plant under the car provides power and heating for use when the car is spotted on

FIG. 36 ALL-STEEL STEAM-GENERATOR CAR FOR CANADIAN NATIONAL

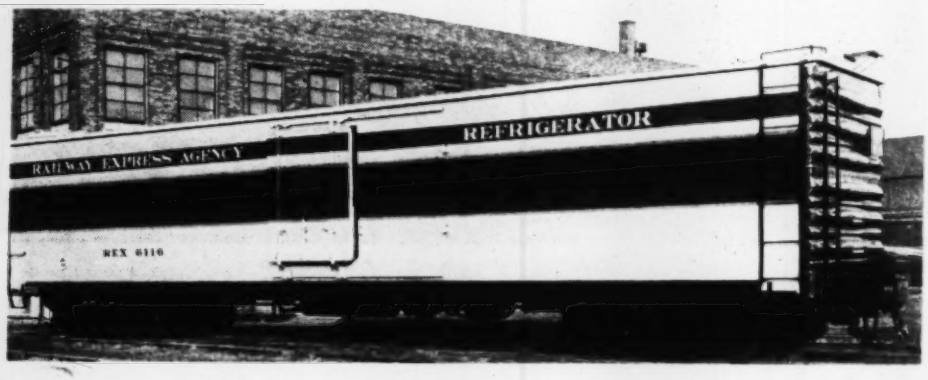

FIG. 37 ALL-WELDED EXPRESS-REFRIGERATOR CARS FOR REA

FIG. 38 ALL-WELDED COAL-HOPPER CAR FOR THE C & O

tracks not so equipped or when the car is being hauled by a freight train. The air-conditioning system is ice-activated.

New twin trains for the New York Central's "Twentieth Century Limited" service were completed during the year by Pullman-Standard. The observation cars on these trains include a feature wherein the floor of the observation end is raised about a foot over the normal level and the high windows reach nearly to the floor, as shown in Fig. 31. In addition, this car includes five double bedrooms and a cocktail lounge.

The full-length diner on the Century seats 68 people in "serpentine" seating arrangements, as illustrated in Fig. 32. Entrance between the kitchen car and the dining car is made through a door controlled by an electric eye.

Fig. 33 shows the barber-secretary-lounge car on the new Century. A telephone booth for mobile radio-telephone service is located in this car.

The same company has delivered to the Rock Island Railroad new-type coffee-shop cars known as the "El Fiestas." The dining and lounge sections are located under bright red and yellow canopies as shown in Fig. 34, and detailed features create an atmosphere of Mexico and the Southwest.

The American Car and Foundry Company has delivered

to the Pennsylvania Railroad its new recreation cars. Each car includes a continuous newsreel theater, a buffet-lounge section depressed below the main level of the car floor, a nursery playroom, and a game and reading room. Cars of this type are now in service on the "Jeffersonian" trains.

An unusual treatment of observation-car ends made its appearance on four cars built for the Milwaukee Railroad in its own shops for service on the Chicago-Twin Cities "Hiawathas." The end of the car, almost completely glass enclosed

FIG. 39 EXPRESS REFRIGERATOR CAR BUILT BY CANADIAN NATIONAL

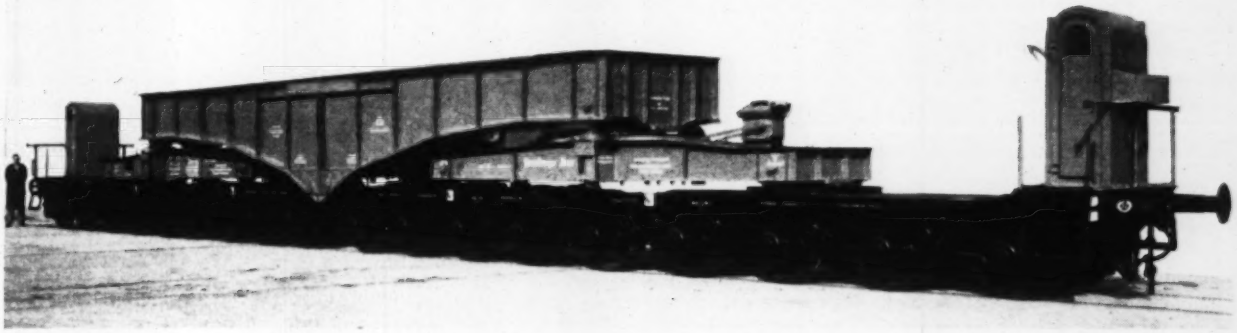

FIG. 40 VIENNA-BUILT HEAVY-DUTY CAR FOR AUSTRIA

including the roof, provides maximum visibility behind glass which is specially heat and glare-resistant.

The French National Railways has received the first of an order for Michelin rubber-tired passenger cars. This order incorporates many improvements, especially in the use of stainless-steel and aluminum-alloy construction, over earlier experimental cars, the first of which appeared in France in 1931. The latest design limits the loading of one wheel to 2240 lb. There are two five-axle trucks on each car, one of which is illustrated in Fig. 35.

The Canadian National Railways has built a steam-generator car to supply heat for passenger trains hauled by Diesel-electric locomotives, Fig. 36. Equipment contained in the car includes an oil-fired boiler, a Diesel-engine generator set, air compressor, two 1100-gal water tanks, a 24-volt battery for emergency lighting and Diesel-engine starting, and 325-gal fuel tank.

FREIGHT CARS

At AC&F's Chicago plant, 50 high-speed express-refrigerator cars for the Atlantic Coast Line, and 500 cars of the same type for the Railway Express Agency were produced. One of these all-welded cars is shown in Fig. 37.

The Huntington, West Virginia, plant of the same company is delivering to the C&O the first group of an order for 6000 70-ton coal-hopper cars. These cars, built on an assembly-line basis, are of all-welded construction, Fig. 38.

Fig. 39 illustrates one of an order for 100 new express refrigerator cars of a new design for the Canadian National Railways and built in its own shops. Each car is equipped with an underslung charcoal-burning heater which is capable of heating the car for a 24-hr period or longer without attention and maintaining constant temperature by means of adjustable settings. A coil of heating pipes underneath the floor racks provides uniform heat in the car at ambient temperatures as low as 45 deg F below zero. In addition, 350 freight-refrigerator cars of similar construction have been turned out by the Canadian National during the year.

What is believed to be the largest freight car ever built in Europe for nonmilitary purposes was recently placed in service on the Austrian Federal Railways. This car, illustrated in Fig. 40, was designed to transport heavy electric transformers weighing up to 408,000 lb. The car has a lightweight of 177,500 lb and runs on 36 wheels subdivided into groups of eight and ten wheels each. This completely welded car has an overall length of 120 ft and can negotiate curves of 20 deg.

ACKNOWLEDGMENT

The Committee gratefully acknowledges the assistance in securing data for the report rendered by the railway press of the United States; by the *Railway Gazette* of Great Britain; by the various railroads, locomotive, car and railway-equipment manufacturers; by the British Railways; by the Netherlands Railways; by the French National Railways; by Ateliers de Construction Oerlikon; Beyer, Peacock and Company, Ltd.; by Brown Boveri Corporation; by Swiss Locomotive and Machine Works; and by Col. H. G. Hill, Corps of Engineers, U. S. Army, who furnished data on the Japanese Government Railways. Special acknowledgment is given to Mr. R. M. Coultas of General Electric Company, for his work in collecting and compiling data for the report.

The Small Manufacturing Company as an Opportunity for Engineering Graduates

By CROSBY FIELD

PRESIDENT, FLAKICE CORPORATION, BROOKLYN, N. Y. FELLOW ASME

THE United States is undoubtedly supreme in the mass-production line. The result of this supremacy has been the leadership to victory of the western economic civilization and its adoption, in some form at least, throughout the world.

Therefore we can take some pride in the mass production of our "engineer factories" and notice the regularity and uniformity with which these manufactured goods arrive on the market. Because of the standardization in educational methods which so happily has been reached, there is little to distinguish the output of the various factories except, perhaps, a slight difference in the color of the cellophane wrapper about each individual unit. This may be any of the spectrum from the violet of New York University to the red of Cornell.

To be sure, we are allowed a certain degree of latitude in the printing of the labels not only by reason of the 180 factories (1)[1] but also from the divergence of the processing within each factory. Thus some labels read "chemical engineer," some "mechanical engineer," some "civil engineer." Undoubtedly, these labels are of some assistance to the personnel manager of the concerns undertaking the risk of giving these goods some chance for display on their organizational counters. None, however, reads "engineer." The chances are, moreover, that any individual winning success will make his achievement in a field not bearing the label of his degree.

There can be no objection to mass production of any article which has or can develop a mass market. We have today, ready to our hand, three large mass markets which can absorb the product just described. These mass markets include large corporations, government and educational institutions. An idea of the production rate of these units can be obtained by the fact that about 21,000 are expected to graduate in 1949 (2), and in 1940 there were some 245,000 persons in the United States who called themselves engineers (3).

It is estimated that because of the War there is an accumulated need for 90,000 engineering students between 1946 and 1950 (4). After this backlog has been filled, at which time nearly one half of all our profession will have entered it in the ten-year period 1940–1950, where is the product of our well-tooled-up engineer factories to go?

ANOTHER MARKET FOR ENGINEERING TALENT

It is essential that we look about for other markets for our goods. In so doing, we may have to modify somewhat the processing or the kind of education that is being sold. It is the object of this paper to point out the results of some experiments in a market which has not been properly exploited. Inasmuch as the relative chances for opportunity in these two entirely different kinds of markets determine largely the answer to many sociological problems which today are confronting us and the answer to which may determine our future form of government, it is hoped that the author will be pardoned if he goes further and points out a few of these implications.

Referring to Fig. 1, it is noted that one half of our workers employed in manufacture are in plants having less than 251 employees each and that these plants in turn account for 92 per cent of the total number of individual plants. The reasons for this have been pointed out in a paper delivered before this Society in 1930 (5), but as some of the matters mentioned at that time are pertinent to our present discussion, a brief look at the small manufacturing plant is in order.

First as to the definition of a small plant. Of the many standards for comparison, the following four are most frequently used:

(*a*) Average number of wage earners employed.
(*b*) The power consumed.
(*c*) The value of production (sometimes modified so as to use instead the value added by manufacture).
(*d*) The capital invested.

Inasmuch as the number of workers is a common denominator not involving variation in price of product or in wage rates, it is a more general index than the others and therefore has been selected for the purposes of this discussion. Thus a small manufacturing plant will be considered as one employing less than 251 workers.

LIFE PATTERN OF AN INDUSTRIAL COMPANY

One other factor is of prime importance in selecting an industry or a specific company within that industry and that is the life cycle. At each step in the growth of an industry or of a company, different characteristics in its staff become more valuable. If any one industry be considered at various times over its life, its growth can be separated into four phases having quite distinct characteristics. These four phases are as follows:

Pioneer. In this phase all of the four characteristics increase, and usually each shows very closely the same percentage of increase. This is the phase of the very small plant.

Expansion. During this phase characteristics (*a*) and (*b*) continue to increase, but (*c*) and (*d*) increase very much faster. This is the phase in which large and small plants are both found, and the total number of plants is relatively large compared to that to be found in the other phases.

Consolidation and Stabilization. In this period, characteristic (*a*) may even show a decrease or, at any rate, a very slow increase; (*b*) usually increases quite rapidly; (*c*) increases slowly; and (*d*) tends to increase slowly or remain stationary. In this phase the number of plants decreases, but the average size increases.

Disintegration. During this period, the industry is losing place to other newly arriving industries. The tendency is for all of the foregoing to show a decrease; (*a*) and (*b*) rapidly; (*c*)

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Education Committee and the Management Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

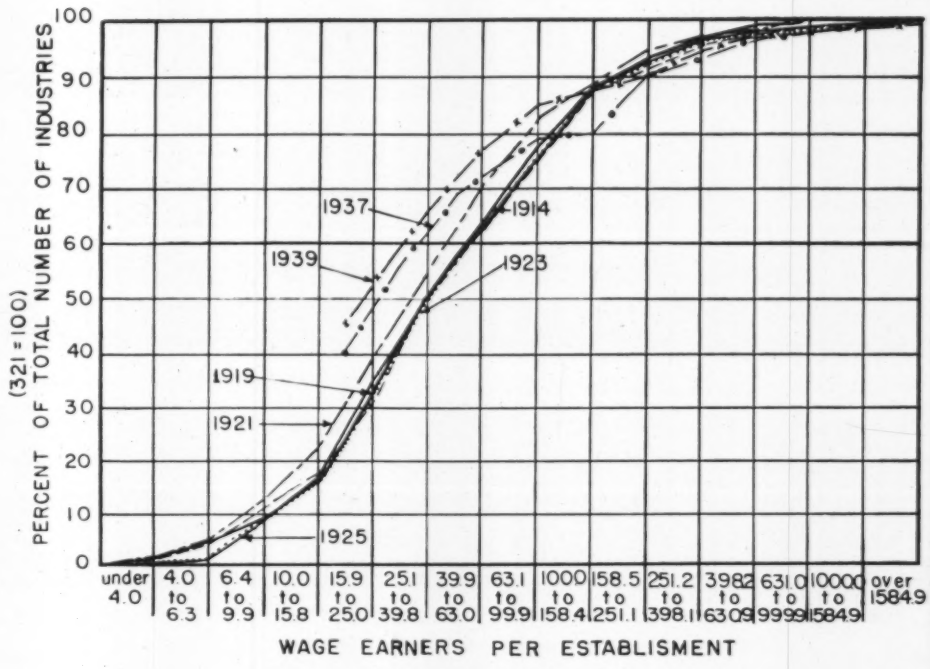

FIG. 1 WAGE EARNERS PER ESTABLISHMENT

(Chart taken from part 3, chapt. 2, vol. 1, of "Recent Economic Changes," published by McGraw-Hill Book Company, Inc., New York, N. Y., 1929, pp. 168–170. This part is by Willard L. Thorp, entitled, "The Changing Structure of Industry, 1937 and 1939 data from Statistical Abstracts of U. S., 1947, p. 815.")

less rapidly; and (*d*) very slowly, sometimes remaining constant. In this period the average size of plant decreases. In rare cases the number of plants may actually increase, showing a transplanting to new locations and subsequent building up there, after the fashion of a new pioneer phase.

It will come as a shock to many to realize that not only a preponderance of small plants exists, but that the relative proportion of small plants has remained so nearly constant for half a century or more. We have been led to believe that the small manufacturing company and the large are mutually competitive and that the large will absorb the smaller or destroy it. This can happen, but should not, as the fact that the functions of the small plant and of the large are not the same becomes better understood. Each should restrain itself to the type of work for which it is best fitted, and if it does not, failure surely results.

RELATIVE FUNCTIONS OF LARGE AND SMALL PLANTS

In the cited paper (5) the details of such types have been discussed, so all that needs to be mentioned here is the general fact that there is an economic limit in the quantity of production of any step that the large plant finds economical, beyond which the smaller plant functions best. Thus in the processing of a product requiring many steps, the small "finishing" plant may be the customer of the large plant and stand between it and the ultimate consumer. Some large plants compete by manufacturing the end product, but this is rarely found to be desirable either from the viewpoint of the larger plant or of the ultimate consumer.

In general, the large plant will be found closer to the source of original raw material, the small plant closer to the ultimate consumer. The small plant, we often say, is the producer of specialties, the large is the producer of standard types.

This is not strictly true, but it is true the small plant must perform some public function in a unique fashion, and this uniqueness may reside in the "articles it produces, the process of manufacture, the way it sells, the territory in which it sells, the trade to which it sells, its fashion of shipping, the method of receiving its pay, its advertising, or even the power given it in the public mind by the personality of one of its members or employees. The degree of uniquity it enjoys is demonstrated by its degree of monopoly, or the quality or price of its products, and is accompanied by its growth in volume and profits (5)."

One factor to be considered is the difference between small plants, a number of which may be owned by a single company, and small plants, each one owned by a different separate company. By far the larger number of small plants fall into the latter category.

What is the small-plant market for the engineering graduate? For a man just out of college, it hardly exists. Should he get a job, he will have to accept a low-paid position, because he will bring very little that the company couldn't get from any other graduate. He is not yet an engineer, only an apprentice. For his own sake, therefore, let him continue along the mass-production line into the large company, not only to complete his education but to evaluate himself and his opportunities.

WHICH ROAD TO CHOOSE?

As he progresses in his employment in the large company, he not only has opportunity to acquire many technical details which may or may not be valuable to him later (it doesn't really matter), but he obtains knowledge of the methods of production, the value of co-operation, the practice of leadership, and the general fundamentals of American "know how." On top of that he should have developed his own philosophy of life and have found for himself the answer to the fundamental question that will determine his future. This question is: Which of the two types of man am I? Am I the type whose inborn nature will be satisfied only by the actual ownership, at least to a large degree, of the tools of production? If so, my

opportunity lies with the small company. Am I the type to whom ownership is a small matter? If so, the use of material things may be sufficient satisfaction, and my opportunity may be with the large organization. In the latter case, the job's the thing, and likely, promotion, influence, and recognition of professional attainments by engineering societies' membership and medals can fill with entire satisfaction the life of the man so constituted.

In the former case, the opportunity to possess the tools of one's profession, the chance of obtaining a piece of property in whole or in part which can be handed down to one's heirs, the willingness to undertake the responsibilities as well as to enjoy the privileges of ownership, all of these show quite a distinct difference in attitude from the desires of the latter case.

In this consideration not only desires but personality should be taken into account. The larger organization frequently presents a more rapid rise opportunity for the man displaying what we may call "political ability."

Let us not mince words, the line of demarcation is clear cut; the love for ownership is the basis of our capitalistic system; the love for control of things owned by somebody else is the first stirring of one of the many forms of socialism.

SECURITY OF EMPLOYMENT

It will be noted that the much maligned word, "security," has been avoided. In what position is one most secure?

In spite of the many ingenious schemes evolved to guarantee security of employment, none seems sufficient. Seniority, pensions, civil service, all have their weaknesses, and even if the Government itself should insure the monetary amount for future safeguard against poverty, events may depreciate the money to the point that the widow's livelihood becomes barely sufficient to buy a package of cigarettes. In our lifetime we have seen the constant flow into economic oblivion from large organizations of men over forty, and the casualties of technical employment among, them and younger men as well, are numerous when organizations merge, or reorganize, or are bought out. In general, security of employment of any kind is apparently present in good times, regardless of the size of the enterprise; in hard times the small plant holds onto its smaller technical staff longer, but in turn may itself fail.

No, there is no security except in insecurity. The only sure way to obtain a secure old age is to take enough risks when young so that the successes more than balance the failures. This requires character, not only in the man but in his wife, and character building in our colleges has been superseded by the absorption of formulas and statistics. One prepares for the future, the other presumes the future to be composed of conclusions based on statistics. One is engineering, the other is technical accounting.

EVOLUTION OF A SMALL BUSINESS

Assume the case of the man prepared to try his chances in obtaining some form of ownership. Let us take the average man, by which we mean the man without money, without means to buy into a small company. How can he obtain his desideratum?

He must be able to give the company something that it needs badly. It will need different things at different times in its growth, depending not only on the kind of product it makes, but also upon the characteristics of the men already owning the company.

The growth curve of a company is something like that shown in Fig. 2.

During A, the "pioneer" period, the perfection of the product and its introduction onto the market are important. If not already pre-empted, a man clever in design or a man of the sales-engineer type will find his opportunities here.

During B, the period of "expansion," not only is there room for both of the foregoing, but there emerges the production man, the tool designer, and the man familiar with automatic machinery. This is the most fruitful phase for the engineer.

During C, the stabilization period, the management man becomes essential.

During D, the financial salesman who can "unload" is perhaps the only man to find opportunity here.

THE ENGINEER'S PLACEMENT PROBLEM

But how can the man find the opening? First he must know he is not going to stay in large-company operations, and therefore, while so working, prepares himself by broadening his studies of his employment, finding out how men in other departments function and what are their duties. He also starts early to look into possibilities, by contacts, through placement agencies, and even careful use of blind advertising.

The opening found may be of a nature whereby he can practice consulting, with permission of his present employers, or if he must leave, he can still obtain their aid. A large company having a good man known to be desirous of getting into a small company may place him with a customer or help him start a business using the company's product, with which he should be familiar and to which he may be favorably disposed.

If, however, a clean break with present employment seems necessary, then the arrangement with the new employer preferably should be a guaranteed salary with a block of stock set aside to be purchased out of earnings on that stock. Many are the varied kinds of arrangements in use today, but they all

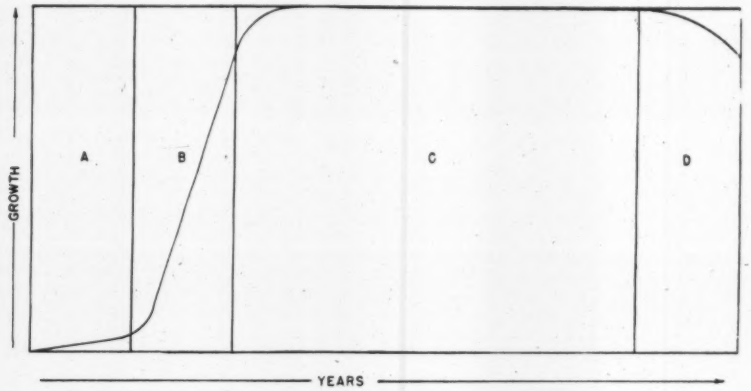

FIG. 2 GROWTH CURVE OF A COMPANY

invoke the taking of considerable risk on the part of the applicant—if business continues to grow, he wins an interest; if it doesn't, he loses interest as well as job.

One little industry well known to the author is composed of six companies; in 1920 there was not an engineering graduate employed. In 1921 one company took on an experienced engineer to be its vice-president in charge of manufacture. All the others followed suit, but slowly, the last company to succumb waiting until 1945. Practically all of these men had won an acknowledged position with a large company before getting the opportunity; one came from the electrical industry, one from the chemical, and another from the motorcar manufacturers. This is just a sample of what is taking place in many small industries.

Men who have held responsible positions in large as well as small organizations have related that it is easier to fill a vacancy in the engineering staffs of the former than in the latter.

SHORTCOMINGS OF THE ENGINEER IN SMALL INDUSTRY

Among the difficulties found with the engineering graduate in the small company are the following: He lacks versatility, he is good in one specialty but unable to take on full responsibility for a major division. (The three major divisions of any company may be called finance, sales, manufacturing.) He is impatient with and therefore not productive in the many nonengineering aspects of his daily work. His is the drudgery of the drafting board, the setting of rates, the arguing with the foremen, the sudden jumping from the laboratory microscope or test tube to the purchasing desk, or the preparation of a claim against a too aggressive vendor. The day may start in the patent lawyer's office and end in municipal court helping the insurance company defeat a claim for injury alleged to have been caused by the product, after which the return to the office finds the union grievance committee waiting. Finally his dash to the door is halted by a machinery breakdown, keeping him in the plant all night. All this is required with no other or very little engineering assistance. In a large company many would be there to help.

Furthermore, he must get results without the elaborate equipment which is his to use in a large company. He must give up many prerogatives which would be considered his by right of employment, such as the number of hours in the legal work week—an hour slighted from the midnight vigil at the plant may show a definite dollar loss which he will have to explain to his associates at their next meeting. It is not an easy life, but, if successful, the reward may be great. Nevertheless, most engineering graduates from large organizations, who try a flyer in a small company, soon return to the easier and more nearly regulated life to which they have become accustomed and which is more nearly in accord with their training. This type of life, moreover, does not offend the mores of the collegiate civilization.

In the recent emergency, surveys by government procurement officers astonished them by the number of small manufacturing plants which could be converted to war work, usually most effectively by acting as subcontractor to a larger organization holding the prime government contract. Even more surprising was the fact that, in the great majority of cases, the owner was not a technical man, even though the process required the utmost exercise of engineering skill. Why are not these businesses owned by engineers?

In the foregoing an attempt has been made to point out some of the reasons, but they can be summed up in the sentence, "because the technical graduate doesn't want the kind of life that starting such a business would require." He would already have a heavy investment in his technical education, and he would be ashamed to fail. So he stands by, intellectually assuring himself and his wife that he is a far superior person to the roughneck individual who jumps into the fray and so often fails. After a few failures we find this same individual a successful businessman, and our engineer of superior intellect doesn't recognize his own failure until he loses his job between ages forty and fifty and then retires to his den to stare at his medals and his engineering-society shingles.

In a recent article (6) based upon Dun & Bradstreet, the Department of Commerce, and the Bureau of Internal Revenue reports, it is stated, "there have never been so many business units in the country as there are today, and not since 1924 have the smallest 75 per cent of U. S. corporations accounted for as large a share of total corporate earnings."

WHERE THEN IS OPPORTUNITY?

All this is fine, you may say, but where do I look for opportunity? In reply, I must give the legendary answer to the ship in the Amazon with a thirst-crazed crew—drop your bucket overside. The fresh water of opportunity is all about you. No product exists today which cannot be made better; no product is secure from the competition of another new product; services there are to give, and old-established products and processes to sell. One specialty alone is crying out to high heaven for competent help, and that is within any small territory—satisfactory repair and maintenance of the products sold by nation-wide organizations.

Criticism is easy, but what constructive suggestions can be made? A very few believed to be among the more important will be stated.

PRACTICAL SUGGESTIONS

First, let the institution take some time to build character. All the technical training in the world still will make only a technical clerk; character as such is the priceless ingredient of a professional man. Engineering is still believed to be a profession, not a technical clerkship. The foundation of character is a philosophy of life adapted to the particular needs of the individual. Perhaps the first requirement of this philosophy of life is a recognition of the great division between the types of men discussed. If a man of the possessive type remains an employee against his nature, he will fester until he forms a cell of disruptive influence.

We are all too prone to substitute mass doctrine acceptance for individual thinking. The primal philosophy of life should give the boy the methods of determining for himself what he wants for his ultimate aim. Perhaps a psychoanalyst should be installed as consultant to the student's appointed adviser; the number whose possessive instincts have been suppressed by training is enormous.

In 1914 a most illustrious man and engineer, Dr. C. P. Steinmetz, whom I did and still admire greatly, assured me that the day of the attic inventor was over, the technical background and the equipment of the large companies would soon monopolize the field of engineering and engineering research. Another great engineer, Dr. Ernst J. Berg, under whom I was then studying, pointed out to me that Dr. Steinmetz was wrong in a certain minor mathematical substitution and might even more easily be wrong in his honest and well-meant advice. For me, Dr. Berg was absolutely right.

I specifically accuse our large engineering schools of producing technical clerks and not engineers, because they omit to point out that on the matters which really count, the decision lies not in the minutiae of science, but in the depths of a man's soul. God and one still make a majority! It would take so little time away from the battle between formulas to deal with this matter, a one hour's orientation course of the history of the

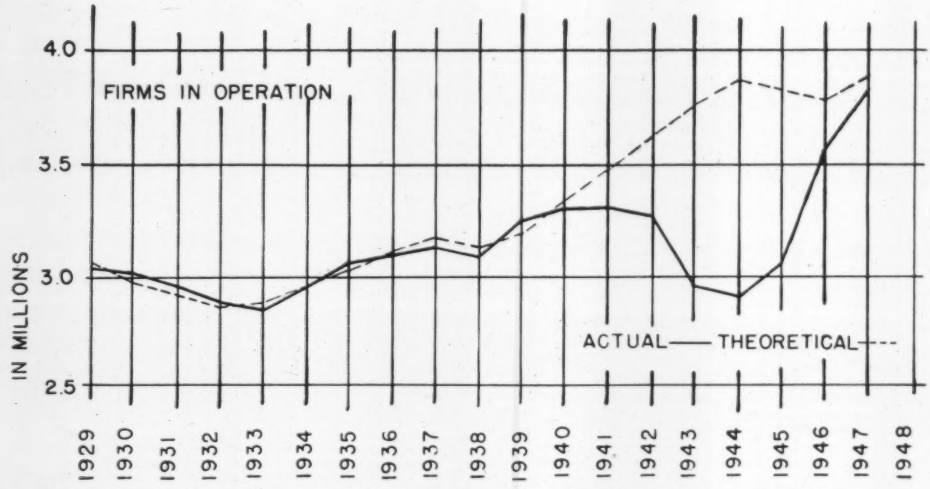

FIG. 3 COMPARISON OF NORMAL OR CALCULATED BUSINESS POPULATION AS ESTIMATED BY THE DEPARTMENT OF COMMERCE WITH ACTUAL FIRMS IN OPERATION

(*Fortune Magazine*, Oct., 1948, p. 86, by courtesy of the Department of Commerce.)

engineer in industry and the present scope of engineering activity alone would help tremendously.

In this course, the duties of the engineer to take economic risks should be emphasized. He is "a commissioned officer in the army of toil," and as such should be in the van of the advance produced by risk-taking. Industrial security is not the slogan for any free man, it is the watchword of slaves. Security for society is obtained only by the risk-taking of a number of leaders. No one can become a leader without taking risks; no one is an engineer who is not a leader, even though his leadership be very limited.

THE ENGINEER MUST BE VERSATILE

Another matter of great pain is our convenient breaking up of our profession into various arbitrary divisions not airtight in operations. Although convenient for both the educator and the engineering society, only the larger organizations can find enough work for an electrical engineer, or a chemical engineer, or a civil engineer, or a mechanical engineer, or a refrigerating engineer. The small company needs a steel-wool engineer, or a motor engineer, or an ice engineer, or a dyestuff engineer, and in order to be such, a man must qualify in a small part of the fields of many of the branches accepted as distinct for purposes of education and forming engineering societies.

There are only two logical divisions of the engineering field; civilian and military. This division is permissible only because of divergence of major interest. In the civilian branch, the emphasis is on cost; in the military, time is of the essence. The comments herein are purposely reserved solely to the branches of the civilian.

Consulting engineering, as a profession, is a partial answer to the problem, but invokes so many other factors and problems specific to itself, that more than a mere mention cannot be afforded in this paper. At best, only a relatively small number of technical graduates can be accommodated in this branch of the profession.

CONCLUSION

In concluding, we should not forget the advantages to our civilization of both large and small plants, and the necessity for the proper balance between them. We have attempted herein to outline some of the features of the small plant and to point out that an opportunity exists in the small enterprise for the engineering graduate. His entrance into that field is highly desirable in order that the small enterprise shall perform its much-needed services to our society and receive the great social reward of survival. Some of the factors of attitude and training involved have been discussed.

We cannot fail to be struck by the paradox of our educational institutions, which, endowed by private enterprise and rendering lip service to the individual, turn out a product trained only for a lifetime niche in a large organization, such as the Government, giant corporations, or monster universities.

If the smaller manufacturing plants of the country be eliminated, the clash of large organizations will transform us into a socialistic society, by whatever name we may call it. Without engineering leadership, the small enterprise is severely handicapped. The selection and training of men for eventual participation in small business represents not only a service to the undergraduate but also a duty to the form of civilization in which we believe. The fundamental of this training is a philosophy of life which will enable a boy to decide if he wants to take the risks of becoming a truly professional man, and also point out the type of future self-education he needs to accomplish this result. And in this achievement, let us bring back respect for the individual and an acknowledgment that God-inspired leaders can still further advance our civilization by their risk-taking for our ultimate security.

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Application of STATISTICS *to the* SCIENCE *of* MANAGEMENT

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THE SCIENTIFIC METHOD

AMONG the very great achievements of human progress has been the development of the scientific method. In essence, the scientific method involves the process of reaching conclusions from reproducible experiment, and not from opinion, hunch, mysticism, folklore, or other forms of guesswork. In detail, the scientific method follows a well-known cycle of events:

1 We state a hypothesis.
2 We design an experiment to test the hypothesis.
3 We collect data.
4 We analyze the data.
5 We draw conclusions from the data.
6 We affirm, deny, or modify the hypothesis. We thereupon state a further hypothesis, and the cycle starts all over again.

The science of statistics plays an important role in the use of the scientific method. The design of experiments, the collection and analysis of data, and the concepts of error or significance, all rely on the methods of statistics for their validity. While the basic decision to use facts at all (rather than to use guesswork) is the truly fundamental achievement, the development of the science of statistics to collect and interpret facts is a most important satellite achievement.

Evolved in the crucible of the scientific method, many long-standing arts emerged as sciences. Alchemy emerged as chemistry, astrology as astronomy, mysticism as medical science. Against the measured beat of the great clock of human history, these changes have been revolutionary in their speed and in the violence of their impact.

Modern industry itself has emerged from this same crucible. Without the scientific method the monster mechanical tools which are the skeleton of our industrial system could not have been designed and built. Without the scientific method, the modern transport and communication necessary to feed these monsters could not have evolved. Without the scientific method, the mechanical energy required to breathe life into these tools could not have been harnessed.

MANAGEMENT BY GUESSWORK

Many managers of today are shocked to be told that business is managed by a methodology which has much in common with the methodology of the Middle Ages. Yet hunch, guess, suspicion, and solidified habit are the rule rather than the exception in management methodology. A few recent examples will be cited:

(*a*) In a plant making precision instruments, the designers, machine-tool builders, and production officials had for decades debated the difficulties of meeting the tolerances on the tiny shafts turned by a large battery of precision screw machines. All except the designers agreed the tolerances were too close. All except the machine-tool builders agreed the machines were inadequate for the job. All except the production officials agreed the operators were careless. The solution had been for decades to have the inspectors sort the parts, a costly operation in itself, while enduring a greater additional cost due to losing more than 10 per cent of production because of defectives.

Then someone applied the scientific method. He measured, with great precision, 500 successive pieces turned out by one of the machines. Analysis of these simple data disclosed the following facts:

1 The machine was easily able to hold the tolerances.
2 The shop gages were inadequate to permit the operators to regulate the machines.
3 The rate of tool wear was so small that the machine, once properly adjusted, could go on for days producing perfect pieces.
4 Numerous suspicions of causes of variation were unfounded.
5 It was possible to do away with the sorting inspection.
6 It was possible to increase production substantially, both in good and in total pieces.

(*b*) A company making and selling building materials was experiencing great difficulty in meeting the prices of its competitors. There were the usual recriminations between the major departments of the company. Then someone applied the scientific method. He analyzed the sales data and found that 5 per cent of the designs of product sold accounted for two thirds of the company's sales. He found that one half of the designs accounted for less than 5 per cent of the sales. A drastic reduction was made in the number of designs. The reduction in sales was small, but the reduction in costs was substantial.

(*c*) A company making chemical products found its maintanance costs high. The number of maintenance men virtually equaled the number of operators. Use of the scientific method disclosed that the ten most important types of equipment failures accounted for over 50 per cent of the maintenance costs. As a result of this disclosure, the company assigned engineering talent to redesign the equipment to eliminate failures of these types, with resultant substantial reduction in maintenance costs.

These examples are sufficient to illustrate what is realized by many, namely, that modern industrial operation is the source of many facts which can be sought out and analyzed to the great benefit of industry.

ACCEPTANCE OF THE SCIENTIFIC METHOD IN MANAGEMENT

The author does not mean to imply that the managers of industry are blind to these potentialities. In some areas, the scientific method has taken firm root. The techniques of time-and-motion study, conceived by Taylor, Gantt, and the Gilbreths, have survived the era of the efficiency experts and have

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

become part of the daily life of industries. Cost accounting has made great strides in measuring and predicting costs. There has been some acceptance of the aptitude test, the systems of merit rating, and other tools of personnel management which rely greatly on statistical methodology for their validity.

In the field of wage determination, the indexes of cost of living and of prevailing wages have been written into numerous collective-bargaining contracts and escalator clauses. Market research is just commencing to use sampling of consumer opinions and reactions. Sales forecasters are beginning to use measures of purchasing power and other economic factors.

This list of applications is all to the good. Yet the fact is that we are applying only a fraction of what we know. The rate of adoption of these managerial tools is so slow as to pose the following question: If the scientific method is so widely applicable to solution of problems of management, how is it that the use of this method is so limited?

This paradox will be discussed by considering the problems of applying the statistical methodology in a field in which the author spent some early years—that of "quality control." Because these problems of application of quality control parallel so remarkably the experience recorded in application of other instances of the scientific method (such as time study, cost accounting, or market analysis), it will be possible to generalize even though the examples are drawn from this one field.

THE SCIENTIFIC METHOD IN QUALITY CONTROL

Few problems in management are more naturally susceptible to scientific analysis than the problem of quality control. Inspectors and operators make myriads of measurements. The resultant data can disclose not only the nature of the product but also the nature of the process which made the product. Through these data

1 The process can be improved to make the product better in the first place.
2 The process can be regulated to perpetuate this improvement.
3 The specifications can be improved through knowledge of process capability.
4 Detail inspections can be eliminated.
5 Scrap, reworks, and other losses can be minimized.
6 Consumer complaints can be reduced.
7 Quality reputation can be improved.

There is nothing theoretical in the foregoing. Personally the author has had experience with instance after instance involving many products and processes in many companies in which all of these things have been done, to the amazement and gratification of the managers involved.

Some of the vital techniques for doing all this are over 20 years' old; accounts of the pioneering work done by the Bell Telephone Laboratories and Western Electric Company were published before World War II. During World War II the problems of expanding mass production of precision apparatus fairly cried for improved means of quality control. Publicity was given to the statistical tools. Training courses were held. Many of the men trained became enthusiasts for the new techniques. The enthusiasm has given birth to an American Society for Quality Control, to a rash of literature, and to a series of frustrations for most of the enthusiasts who have endeavored to translate the techniques into action. The proved techniques have made comparatively little headway.

The failure to apply the techniques has certainly not been due to any desire on the part of managers to perpetuate scrap losses, inspection costs, and customer complaints. The managers quite obviously want to improve their performance in these respects. Granted, there is some indifference among those managers who are drugged by favorable profit statements and who are not driven by economic necessity to spend time on how to improve operations. But in the main, managerial attitude toward the objectives of quality control is one of long-standing agreement.

Neither has the failure to apply the techniques been due to lack of technical knowledge on the part of the industrial statisticians. In the author's experience, the bulk of the quality-control problems are, in statistical contemplation, rudimentary rather than complex. Even an amateur statistician can solve most of them; so much so, that some managers and engineers constantly solve these problems without realizing they are making repeated sojourns into the field of statistics. They are much like the man who speaks prose without knowing it.

We must grant that some of the present "quality-control engineers" are of a very recent vintage. However, they know enough of statistical techniques to solve the bulk of the statistical problems which they encounter. Their failure lies not in their lack of statistical knowledge. It lies in their lack of knowledge of the nature of the managerial process and, in particular, in their lack of knowledge of human relations.

STARTING BIG VERSUS STARTING SMALL

Here are a few actual (though disguised) examples. The W. Company is a large manufacturer of electrical apparatus. The vice-president of manufacture became convinced that quality control by statistical methods had broad application to his work. Providing a generous budget he promptly set up a quality-control department of about 20 engineers. In short order, the plant superintendents and foremen found themselves confronted with men who presented mysterious charts with data on defects, who wanted to investigate the processes, who proposed many innovations to help these superintendents who wanted no charts, no investigations, no innovations, and no help. The inevitable consequence was a full-scale jurisdictional deadlock. At the end of a year the vice-president reviewed accomplishments and found that nothing had been accomplished. Thereupon he disbanded the quality-control department.

In contrast is the experience of the Y. Company. Here the vice-president was also convinced that modern quality-control methods could improve his operations. However, he engaged only one engineer to apply the methods. Furthermore, because no one in the company had ever installed a system of modern quality control anywhere, the vice-president engaged a qualified management consultant, one who had supervised many such installations, to help the engineer chart a course. For the first few months the engineer was strictly confined to one operating department. The subsequent results were beyond all expectation in reducing scrap losses and cost of inspection.

As a consequence of this success in the first department, it was decided to expand the quality-control work to other departments. Consideration was given to holding a meeting of all foremen to explain the gratifying results obtained and to have the foremen of the first department "testify" to his fellow foremen that there was nothing to fear. It was then found that no such meeting would be necessary. The story had already been told by the "grapevine." The foremen were already "sold" and were competing with each other for the right to be the next to obtain the services of the quality-control engineer.

The decisive factor which contrasts these two experiences is that, in the successful instance, it was recognized that time is an essential ingredient in the solution. Adoption of the scientific method is a fundamental change requiring time to con-

summate. The larger the mass to be changed, the greater the time necessary. The broad front attack in the W. Company represented too violent a rate of change and was doomed to failure from the outset. The idea of a guided gradual growth, as adopted by the Y. Company, greatly increased the odds for success.

THE NEED TO SELL THE TECHNIQUES

To many quality-control engineers, the inability to "sell" the shop executive is the main cause of frustration. From the viewpoint of the quality-control engineer, here is a proved set of techniques whose logic is unassailable; "therefore" anyone who does not accept the logic is an obstructionist and should be commanded to comply. This is all very well, but it ignores the views, the responsibilities, and the rights of the shop executive.

Sound organization practice requires that if the shop executive is to be held responsible for conduct of shop affairs, he must be given coextensive authority to regulate those affairs. If the top management adheres to this sound organization practice, it will not tell the shop executive he must adopt certain techniques. To tell him he "must" do something is to relieve him of the responsibility for any failures which might be assigned by him, rightly or wrongly, to these techniques. The top management can only ask that the shop executive give consideration to these techniques. From there on, the quality-control engineer is on his own. He must sell his service by demonstration, by persuasion, by patience, and by all other known devices of salesmanship, including of course the excellence of his service.

To most engineers or scientists, selling seems to be an unnecessary, distasteful, and degrading chore. That they think so is an indictment of their technical training quite as much as an indictment of their lack of experience in human relations. Actually, there is no excape from the need to sell, nor should there be. If the quality-control engineer cannot convince the shop executive through the democratic process of free choice the matter should end there. Progress achieved through dictatorial methods is achieved at too high a price in human relations.

THE METHODS OF SELLING

On the face of it, the requirement that the techniques must be sold rather than forced on the shop executive means that there will be no progress. The precise opposite is true—only through genuine conviction is there any enduring progress. As stated previously, the shop executive for many years has been in sympathy with the objectives of quality control. Yet the usual approach of the quality-control engineer is to dwell on these objectives as though they were unknown to the shop executive. As to these objectives, it is the quality-control engineer who has newly rediscovered them, not the shop executive.

In contrast, the quality-control engineer devotes little time to explaining, in shop language, how the new methods are to be any improvement over traditiona' methods for achieving these long-standing objectives. The common, and fatal, approach is to try to teach mathematical statistics to the shop executive.

Not long ago, after the author had just gone through explaining to a vice-president what was involved in adopting modern quality control, he confided to me that he had once sent some executives to a wartime course in quality control to find out what it was all about. They came back with the report, "quality control is a blackboard full of higher mathematics." He was unable to see the connection between that report and his work, so he dropped the whole thing.

The shop executive has some honest doubts as to how an engineer who has never seen a particular process can arrive at a knowledge greater than that possessed by supervisors who have been associated with that process for 25 years. These doubts cannot be answered by paternal smiles; they must be answered squarely. In the case of the precision screw machines related earlier in the paper, a comparative handful of data ended an argument which had gone on for decades. The ability of the engineer to develop the new knowledge was purely the result of his being armed with a new tool—the tool of the scientific method—the use of facts rather than debate to arrive at conclusions.

The author often has used analogy to explain this. A shop supervisor has for 25 years been inspecting surfaces with the naked eye. One day an engineer invades the department armed with a microscope. On that day, the engineer, with only one day's observation, can make new disclosures about those surfaces to the man who has examined them for 25 years. Or, consider the fast-moving mechanism which is photographed by a high-speed camera. On the day the film is projected, there are available new disclosures to the man who has worked with that mechanism for 25 years.

In all three instances, it was the new tools which made the new disclosures possible. The analysis of data, the microscope, the high-speed camera are of the same species. The last two, being physical, tangible devices, are more obvious than the "mental" tool of analysis of data. But all three can be explained to the shop supervisor as tools.

LABORATORY TOOLS AND SHOP TOOLS

A common cause of failure is the inability to distinguish between laboratory tools and shop tools. The ordinary micrometer is less than a hundred years old. We can easily visualize that in the early days of machine-shop practice, a measurement by micrometer was quite a ritual. The shopman went to the laboratory and waited respectfully while the engineer (in a laboratory coat) took the instrument from its velvet case and made the measurement. Over the years, the instrument has been simplified, and shop training broadened to the extent that today the micrometer is in widespread use as a shop tool.

The use of statistical tools will follow a similar pattern. Some of these tools are already so simple that they can be put into shop hands at once. It is often very useful to chart measurements of individual units of product against the design tolerance limits. From his experience, the author has yet to encounter an operator or shop supervisor who could not understand such a chart, and therefore this chart is classified as a shop tool.

On the other hand, it takes me several class sessions to get across even to graduate engineering students the concept of the Shewhart control chart for comparing averages with statistical boundaries for variations in averages. The Shewhart chart, along with problems in analysis of variance, theory of sampling, and a host of others, is in the laboratory-tool category. Any effort to force these tools prematurely on the shop is bound to generate the resistance which accompanies suspicion of the unknown.

It is not meant that the engineer is precluded from using these laboratory tools. The lesson is merely that laboratory tools are to remain in the laboratory until it is timely for them to go into the shop.

THE NEED FOR A PROGRAM

Finally, the quality-control engineer, in the absence of broad managerial experience, does not realize that introducing a new methodology requires a program or series of events. The actual use of the new techniques is only one of these events.

The breadth to which this program can extend is exemplified by the actual program of a company in the textile industry. This program includes the following:

(*a*) Economic analysis of what is to be gained by achieving improved quality.
(*b*) Measurement of competitors' quality and comparison with the company's own quality.
(*c*) Raising the level of quality-mindedness among all levels of personnel.
(*d*) Improved organization of the inspection department.
(*e*) Improvement in completeness and adequacy of quality specifications.
(*f*) Development of adequate check inspection and quality audit procedures.
(*g*) Measurement of individual operator quality performance.
(*h*) Improvement of materials purchased from vendors.
(*i*) Development of training programs for various classes of personnel.
(*j*) Identification of major projects for quality-control research.
(*k*) Establishment of steering committees for achieving co-ordination among the principal departments of the company.

In the framework of such a list, the detailed application of the statistical techniques is seen in correct perspective. The statistical techniques are never a program in themselves. They are only part of a broader program. Failing to realize this role of the techniques, the quality-control engineer can fail for lack of perspective quite aside from other considerations.

CONCLUSIONS

We can generalize from the example of quality control to draw conclusions which apply to the use of statistical methods in the science of management.

(*a*) Statistics is not an end in itself but only an adjunct in applying the scientific method.
(*b*) The practitioner of statistical methods must be aware of the broader program of managerial endeavor of which his specialty is only one element.
(*c*) Application of statistical methods must commence on a small scale and must grow with due regard for the time needed to grow solidly.
(*d*) The statistical methods must be sold by all the arts of salesmanship. They cannot be forced on the executives of industry.
(*e*) The intricate methodology must be kept in the background for use by the engineer only; the simple methodology may be introduced into the shop for use by the shop personnel.
(*f*) The statistical practitioner must learn of the technology of management. He cannot expect that the managers will want to learn of the techniques of statistics; they will want to learn only how these techniques can aid them to carry out long-standing management objectives.

Education and Training

AN article by A. F. Tinsley, received through the courtesy of British Information Services, describes how Great Britain is overcoming the current engineer-scientist shortage. According to Mr. Tinsley, nearly 2000 young men are now training to be engineer-scientists under the Ministry of Supply's "Scheme for Engineering and Craft Apprentices," one of the largest of its kind in Britain, to relieve the present acute shortage of skilled scientists and technicians in industry. Industry in Britain, which is responsible for the success of the export drive, could absorb immediately 5000 such men if they were available. Realizing that this lack of engineer-scientists must be overcome, the Ministry of Supply attaches great importance to its training scheme which is now two years old.

The scheme takes in 28 establishments, including many Royal Ordnance factories throughout Britain, where apprentices working under skilled craftsmen, are taking five-year courses in engineering. These range through the mechanical, electrical, and aeronautical fields, to the radar, atomic-energy, gas-turbine, and aircraft-design fields. At the end of their courses the apprentices will be qualified engineer-scientists fitted to occupy key positions in industry at home or overseas.

Candidates for the program are all between the ages of 16 and 18, and are products of secondary schools, public schools, grammar schools, and modern schools. The examinations arranged by the Civil Service Commission are stiff and include written papers, aptitude tests, and personal interviews with Ministry officials whose job it is to see that only the very best candidates are selected. Failure to obtain a certain percentage of marks in the written papers automatically disqualifies a candidate from taking the aptitude tests and personal interviews, and he cannot therefore be accepted.

The successful apprentices are distributed among the various establishments of the scheme. In so far as possible they are given a choice of where they wish to be sent.

All the apprentices are paid weekly salaries, plus maintenance allowances, which vary accordingly to whether the apprentice is stationed in London or elsewhere in Britain.

According to the type of engineering the apprentice wishes to learn, he may find himself training at Woolwich Arsenal, chief of all the Royal Ordnance factories; the Royal Aircraft Establishment at Farnborough, Hampshire, Britain's largest aeronautical experimental establishment; The Atomic Energy Research Establishment at Harwell, Berkshire; the Telecommunication and Radar Research Establishment at Malvern, Worcestershire; or the National Gas Turbine Establishment at Whetstone, Leicestershire.

During the war many men training for engineering at various centers had their studies interrupted by service in the Forces. Under the new postwar scheme, the Ministry of Supply makes it possible, for those who wish, to resume their studies and thus complete their engineering courses. Many such men are now back at the bench and lathe, completing their engineering studies as members of the new program, enjoying the same benefits as the 16 and 18-year-old apprentices.

Under the Ministry scheme, selected apprentices, after at least one year's training in the workshop, who have matriculated (or obtained exemption from matriculation on entry), may be given the opportunity to attend a full-time university-degree course. These courses will consist of full-time lectures for one term, which will alternate with practical workshop experience during the university vacations. Tuition fees, wages, and maintenance allowances for apprentices living away from home are paid during the university terms. Throughout an engineering apprenticeship, a specially arranged course is given in training workshops, drawing offices, departmental workshops, and laboratories.

Craft apprentices for the program are recruited locally by the Craft Apprentices Board in each establishment concerned, normally at the age of 16, while engineering apprentices are recruited through the Civil Service Commission's examinations.

CHANGES IN BUSINESS FINANCE[1]

By DONALD S. TUCKER

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EVERY experienced businessman knows that the problems of financing his business now differ considerably from those of thirty years ago when he was starting his career. Few of us, however, were aware of either the universality or the complexity of the changes in business finance until the National Bureau of Economic Research published the results of its recent survey.[2]

The significant causes of change are surprising. Increase of the corporate income tax has, for example, operated to favor debt financing. If this change alone were significant, it would create an enlarged demand for loanable funds and therefore an apparent shortage of such funds. There is also still some complaint about federal regulation of security issues. Since public issues of new securities have always consisted chiefly of bonds, the Securities Act should tend to intensify still further any shortage of loan capital. Businessmen, however, recognize that loanable funds are far more readily available now than they were a generation ago. A common complaint at this time is the shortage of equity money. Changes in the structure of our financial institutions and changes in the structure of nonfinancial business have in fact been far more significant than changes in federal policy.

Many businessmen still think of the commercial bank as an important source of funds for business. One piece of simple arithmetic will reveal how far from the truth is this old-fashioned belief. Equity money in 1940 supplied 60 per cent of all business assets. Long-term debt supplied an additional 22 per cent. Short-term debt supplied only 18 per cent of all business assets. Within this 18 per cent, trade credit was the largest single source of funds, and debt to miscellaneous creditors (accrued taxes, accrued wages, etc.) held second place. Commercial banks held only 17 per cent of this 18 per cent of all liabilities. Within this 17 per cent a small portion consisted of open-market purchases (commercial paper, acceptances, and the like), so that short-term direct loans by commercial banks furnished only 93 per cent of the 17 per cent of 18 per cent of business assets. $(0.93)(0.17)(0.18) = 0.0297$. Short-term direct loans by banks now apparently supply less than three per cent of the funds used by nonfinancial business enterprises.

Commercial bankers, however, would like to make more loans to business. One evidence of their willingness to lend is the extent to which these banks have made long-term loans. Of the 22 per cent of business liabilities represented by long-term debt, about 16 per cent are held by banks. Nearly half of this 16 per cent consist of bonds purchased in the open market. The businessman secures such funds normally by approaching some investment banker; but 53 per cent of this 16 per cent of the 22 per cent of business liabilities consist of direct long-term loans made by banks. $(0.53)(0.16)(0.22) = 0.0187$. Long-term direct loans made by banks supplied, therefore, almost an additional two per cent of the assests of nonfinancial business. Commercial banks directly finance nearly $3 + 2$ or 5 per cent of the assets of nonfinancial business; but in order to hold even this small portion of all business financing, it has been necessary for these banks to invest heavily in long-term debt, an operation well outside of their traditional field of activity.

Four elements seem especially significant in this growth of long-term lending by commercial banks. (1) The total assets of these banks (10.4 billion dollars in 1900 and 66.7 in 1940) have grown more rapidly than either the national wealth (89 billion dollars in 1900 and 309 in 1940) or the national income (16 billion dollars in 1900 and 66 in 1940). Banks have therefore been compelled to seek new outlets for their funds. Consumer loans and government bonds have been only two of these new outlets. (2) Intensified competition from finance companies, commercial-credit companies, and even from insurance companies for loans of the old-fashioned type has compelled banks to accept loans which they formerly refused. (3) Businessmen have since 1920 become less willing to accept short-term loans from banks. The notes payable of 84 large manufacturing corporations, for example, expanded from 226 million dollars in 1900 to 857 millions in 1920; but by 1922 the notes payable of these companies had shrunk to 273 millions, and with the return of prosperity in the twenties this liability failed to re-expand. These corporations in fact continued, though somewhat irregularly, to reduce their debts of this type. By 1939 the total notes payable of these same 84 corporations amounted to only 88 million dollars—about one tenth of their 1920 debt of this type, and only about one third of their borrowings in 1900. Periods of severe credit deflation have taught businessmen lessons that they are apparently unwilling to forget. The stronger business corporations, to whom other sources of funds are open, now issue very few notes payable. Short-term borrowing from banks is done chiefly by firms that cannot secure funds in other ways. (4) The structure of nonfinancial business has also been altered, and this last change deserves brief description here.

Changes in the structure of business include three elements that are of especial importance to banks. (1) The average size of the business unit engaged in manufacturing is now larger than in 1920. Extremely small business units may fail to borrow because they are unable; but small and medium-size enterprises constitute the bulk of bank borrowers. Larger firms are able to issue bonds and the largest may even be able to issue also stock for sale to investors. Enlargement of the business unit during the last thirty years has brought many firms up to the size that makes possible a public issue of securities, and for this reason they no longer need to borrow heavily from banks. (2) Wholesalers were an important outlet for bank credit in 1920; but the increased speed of transportation has diminished the relative importance of wholesalers. This outlet for loanable funds has therefore also been diminished. (3) The number of farmers has diminished both relatively and absolutely. All these changes have decreased the demand for bank credit. In 1920 loans to borrowers engaged in manufacturing, trade and agriculture constituted 61.4 per cent of all bank loans. By 1940 borrowers in these three industries received only 27.7 per cent of all bank loans. It follows then that even if banks had faced no new competitors in the supply

[1] One of a series of reviews of current economic literature affecting Engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] Neil H. Jacoby and Raymond J. Saulnier, "Business Finance and Banking," National Bureau of Economic Research, New York, 1947, 241 pp., $3.50.

of short-term loans, they would, nevertheless, have suffered some loss of income because of this diminution of the total demand.

In their struggle to find new sources of income the banks have levied charges against depositors, created personal loan departments and invested heavily in government debt. New activities of these types are, however, quite properly omitted from a survey of business finance. New activities within the field of business finance include the rapid development of three classes of borrowers that were formerly unimportant. These newly important borrowers are (1) public utilities including railroads, (2) factors and commercial finance companies, and (3) real estate. For enterprises of all kinds there are also new techniques of lending.

New techniques of lending are of several kinds. (1) For the borrower whose equity capital is too small to warrant an unsecured loan there is accounts-receivable financing. Under this plan the bank may lend 70 to 90 per cent of the pledged accounts without notifying the people whose accounts are pledged. The borrower must of course substitute other accounts for those that fall into arrears. (2) For the exceptionally solvent firm there is the revolving fund. Here the bank accepts a fee in return for which it promises not to revoke a line of credit during some stated period. (3) The firm dealing in staple commodities is allowed to create a new subsidiary, the "field" warehouse, which issues warehouse receipts that will be accepted as collateral, perhaps for 65 to 85 per cent of the value of the merchandise thus warehoused. (4) To the firm buying new equipment the bank may make directly or indirectly a secured loan repayable in installments. (5) For the large borrower there are correspondent relationships under which one bank negotiates and "polices" a loan in which many banks participate as lenders. (6) Most interesting of all is the "term loan" repayable by installments and made always under a special agreement in which the debtor promises to conduct his business in a prescribed fashion during the term of the loan. There is apparently no uniformity among these loan agreements. Each is "tailor-made" to fit the particular borrower. The cost of thus "tailoring" each specific loan almost necessarily limits these contracts to loans for very large amounts. A term loan therefore differs from a private placement of securities more in form than in substance; but the term loan does not involve a sale of securities that are, in form at least, marketable. Lending banks, therefore, find it difficult to relieve themselves of these term loans by re-sale.

New financial institutions include credit unions, personal finance companies, sales finance companies and industrial banks for consumers. For business there are, on the one hand, commercial credit companies of various kinds that buy liens on inventory or equipment, or advance money on receivables either with or without notification of customers. For business also there are, on the other hand, many government corporations, of which those most active in the field of business finance have been the Export-Import Bank, the United States Maritime Commission, the Federal Reserve Banks and the Reconstruction Finance Corporation.

Most significant of all perhaps has been the rapid growth of the 49 large life insurance companies that hold 90 per cent of all life-insurance assets. The growth of the investments and "reserves" of these companies has been almost comparable to the growth of the federal debt. By 1940 these companies were financing 5.7 per cent of the assets of nonfinancial American business. Their loans to business were already larger than the direct loans of all commercial banks. Even if the open-market purchases of these banks were added to their direct loans, the bank total (6.58 per cent) was in 1940 only slightly larger than the long-term debt held by these insurance companies. Preparation for war increased, it is true, the business liabilities held by banks; but after 1941 business again began to pay off its bank debt. It is therefore still possible that at some future time these 49 large companies may replace the 14,000 commercial banks as the chief source of business loans.

Though these new competitors and the new methods adopted by banks to meet this competition constitute perhaps the most significant changes of the last thirty years, the most impressive result of this recent survey is a condition which was apparently almost as true in 1900 as it is at the present time—the large concern finances a larger share of its total assets with equity money than does the small concern, and when the large concern borrows, it issues chiefly long-term obligations. The large concern, it is true, has during the last thirty years diminished still further its notes payable; but the shortage of short-term borrowers which now confronts commercial banks is due at least as much to growth in the size of the business unit as it is to the increased preference of businessmen for other sources of funds.

The present relative shortage of equity money is due to many causes; but these causes clearly include business policy, growth in the size of the business unit, and the relative decline of wholesale trade. All of these influences have tended to make short-term loans more readily available for those willing to borrow in this fashion. Growth of life-insurance assets and the entry of banks into the term-loan field have made long-term loan funds also more plentiful for borrowers. With common stocks now selling at fourteen times their annual dividends while bonds sell at more than thirty times their interest payments, it must be admitted that equity money is now scarce when compared with loanable funds; but is it not possible that this condition indicates only that the demand for capital of all kinds is now exceptionally large and that enlargement of the supply of equity money has not been as rapid as this extraordinary increase in the availability of loanable funds?

The Load-Carrying Ability of Hydrodynamic Oil Films

(*Continued from page 296*)

Newkirk, Proceedings of the General Discussion on Lubrication and Lubricants, The Institution of Mechanical Engineers, London, England, May, 1938, pp. 223–226.

34 B. L. Newkirk and H. D. Taylor, reference (28).

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BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Guided Missiles

A PROGRAM to purchase guided missiles and allied equipment to be used in a new training program of Air Force guided missile launching crews, was announced recently by Gen. Hoyt S. Vandenberg, U. S. Air Force Chief of Staff.

President Truman certificated $10,300,000 for this purpose on January 13. Last fall he certificated $16,200,000 and this total will now be used in procurement of the missiles and allied equipment for operational training and experimentation.

Two Air Force guided missiles were also announced for the first time.

One is the 32-ft-long Consolidated Vultee 774, the first Air Force missile approaching the size of the German V-2, which is about 45 ft long. The 774 was successfully fired by Air Force technicians at White Sands Proving Ground, N. Mex., and is being considered as an Air Force training missile.

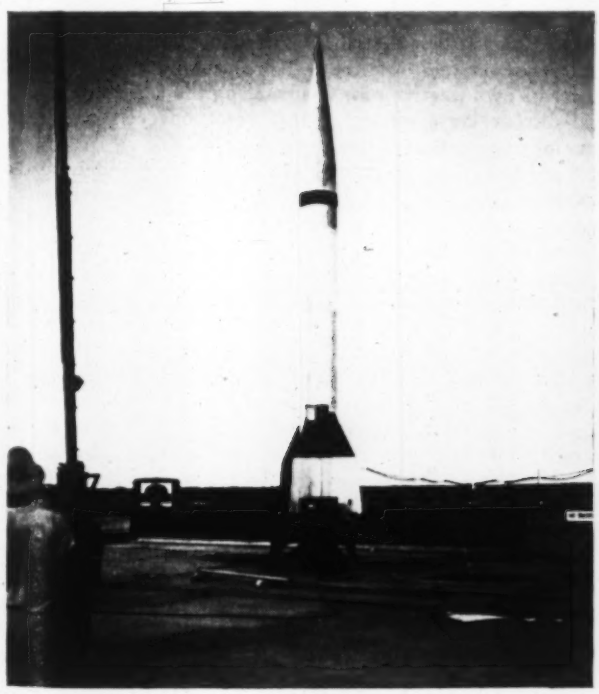

FIG. 1 THE U. S. AIR FORCE CONSOLIDATED VULTEE 774, FIRST U. S. AIR FORCE MISSILE APPROACHING THE SIZE OF THE GERMAN V-2, IS SHOWN DURING LAUNCHING PREPARATIONS AT WHITE SANDS PROVING GROUND, N. MEX.

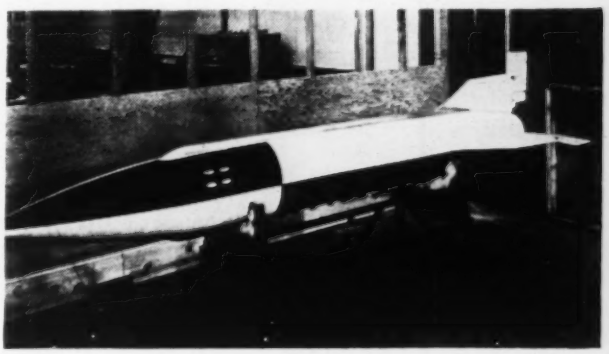

FIG. 2 THE NATIV, U. S. AIR FORCE ROCKET TEST VEHICLE, IS SHOWN AFTER ASSEMBLY, PRIOR TO FIRING AT HOLLEMAN AIR FORCE BASE, ALAMOGORDO, N. MEX.

The second is a smaller rocket test missile, the North American NATIV. It was fired at Holleman Air Force Base, Alamogordo, N. Mex., last summer. The NATIV is approximately 13 ft long.

Both rockets have been fired without incident several times since the tests began more than six months ago. More than two years in development, both missiles are powered by liquid-fuel rocket motors, and both have reached supersonic speeds.

The 774 was designed to test the operation of advanced types of rocket vehicles and for experimentation with new launching techniques, handling devices, fuels, and rocket propulsion

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

motors. In addition, it is suitable for upper-atmosphere research, being one of the few rocket vehicles available potentially capable of attaining altitudes of more than 100 miles.

Other types of missiles with this altitude potential are under development by the Army and Navy. These include the Army's WAC series and the Navy's Aerobee and Viking (formerly Neptune).

The NATIV is a test vehicle for aerodynamic research, development of control systems, and training of rocket launching crews. It has attained a trajectory altitude of more than 10 miles. The NATIV is fired from a tall metal tower, moving on guide rails within the tower during the first few seconds after firing.

Both the Air Force rockets have long needle-sharp noses and four movable control fins. The 774 has a center diameter of approximately 30 in. The NATIV has a diameter of about 18 in.

Although outwardly similar in appearance to the German V-2, the 774 incorporates many design improvements, including improved stabilization controls which insure better launching characteristics.

High-Altitude Rocket

THE highest altitude ever reached by any man-made object, over 250 miles, was attained recently by a two-stage rocket missile fired by the Army Ordnance Department at its White Sands Proving Ground, N. Mex.

At the peak of its flight the rocket was, for all practical purposes, outside the earth's atmosphere. The rocket's highest speed was more than 5000 mph.

Major General Henry B. Sayler, chief of the Ordnance Research and Development Division, who made this announcement, said that the new altitude record is two and one fourth times greater than the previous record of 114 miles into the air, which was also made by the Ordnance Department at White Sands, using a captured German V-2 missile. The top speed of the missile was several times that of the announced world speed record for aircraft. By comparison, even the unannounced speed of rocket-propelled airplanes is slow.

"This successful flight is significant in a number of ways," General Sayler said. "So far as is known this is the world's first successful multistage liquid-fuel rocket. It emphasizes the fact that we have jumped far ahead in the development of high-altitude missiles.

"Second, it gives an indication of the distance possibilities with missiles of this type. No prediction can be made as to the possibility of hitting a given target 5000 miles away, but even now we can attain a range of hundreds of miles.

"Third, while there has been much conjecture as to a possible man-made satellite to circle the earth continuously, it must be admitted that this flight brings much closer the time when such a satellite could be launched. I say 'could be,' for I am not sure whether such a missile will ever be successful or serve a useful purpose.

"Finally, it is considered that the success of this flight opens up new vistas for scientific research in the field of guided missiles and exploration of the unknown reaches of the atmosphere."

The great increase in altitude performance was made possible by use of the step-rocket principle, in which a small or second-stage rocket is launched at great altitude and speed from a larger first-stage unit. By using this combination the final speed of the second stage is the sum of the independent velocities of the two missiles if fired alone. Solid-propellant rockets are commonly used as boosters for launching ramjets and anti-aircraft missiles, and operate on a similar principle. However, their fuel is expended in a very short time, and they do not achieve the altitude or velocity of the liquid-fuel step rocket.

Two available designs were combined to produce this step rocket. The first stage was built by modifying the V-2 missile, 100 of which were brought to this country by the Army Ordnance Department in 1945. The second stage was an American rocket known as the WAC Corporal, first flown at White Sands in 1947. The nature and extent of the modifications cannot be disclosed, although it can be stated that the WAC replaced the war head of the normal V-2.

The V-2 and WAC were chosen for the project because they were readily available, and because their use was more economical than development of completely new designs.

General Sayler also pointed out that the two-stage missile is entirely experimental, with most of the effort to date being expended in attaining successful operation. It is designed to carry a small pay load, however, and this capacity was used in this flight to secure hypersonic—many times the speed of sound—aerodynamic data. During several earlier flights, made to test equipment, only small quantities of propellants were carried and no records were broken.

The vehicle was designed and constructed jointly by the General Electric Company, the California Institute of Technology, and the Douglas Aircraft Company.

Continuous Mining Machines

TWO new continuous coal-mining machines which may revolutionize the coal-mining industry were introduced during the last quarter of 1948, according to an article in *Mining Engineering*, February, 1949, by John V. Beall, the managing editor. One of the machines, the Colmol, was made by the Sunnyhill Coal Company; the other, called the Joy Continuous Miner, was manufactured by the Joy Manufacturing Company.

The Colmol, best described as a giant mole, advances the entire face in one operation. The machine moves forward under its own tractive power, advancing the face continuously and discharging a stream of coal onto conveyers or shuttle cars for transportation from the mines.

A series of rotary chipping heads, each having widely spaced and progressively receding teeth, chip the coal in overlapping annular concentric kerfs, causing coal to be free from the pressure of the earth and to break out ahead of the teeth. These chipping heads also function as paddle conveyers which sweep the floor of the mine and co-operate with a floor-shearing blade to remove coal from the face and sweep it to a conveyer which loads the coal and carries it to the rear of the machine where the coal is delivered to the transportation system. The widely spaced, radially disposed teeth on each of the chipping heads are not only progressively receding from the center of the rotation but they are also connected by rearward-sweeping sharpened edges that remove coal from between the teeth if it has not been previously chipped free of the face ahead of the teeth.

Hydraulic cylinders are employed to move the entire cutting-head assembly up and down, to tilt it forward and backward, and to vary the distance between the top and bottom rows of the cutting heads. Each of these motions may be controlled separately by means of manually operated control valves which enable the operator to position the cutting head of the machine accurately. Other hydraulic cylinders are provided to raise and lower the tail of the conveyer to suit the position of the shuttle buggy or conveyer. The Colmol is a completely mobile unit, being driven on endless tracks which are designed to turn

the machine on a radius materially shorter than its length, thereby reducing the problem of maneuverability in confined passages.

All of the drives are hydraulic, the various pumps being driven by 230-volt direct-current motors as follows: two of 30 hp for the rotating heads and two of 7½ hp, one each for the conveyer and traction drives. The machine is 8 ft 6 in. wide, 24 ft 9 in. over-all length, 38 in. high, and weighs 26 tons. The size of cut made is 9 ft 6 in. wide, 48 in. high, and an advance of 18 to 36 ipm is claimed. The Colmol is expected to produce 500 to 1000 tons per shift. To accomplish this, it is proposed that one foreman, one machine operator, and two timbermen will make up a machine crew.

The Joy Continuous Miner consists essentially of a ripper bar or head which tears the coal from the face, discharging it into an intermediate conveyer which loads into a centrally located hopper. From this point the coal is picked up by the rear conveyer which carries it back to the transportation means. Both conveyers and the ripper head are mounted on a main frame which carries the auxiliary equipment and is in turn mounted on caterpillars. The ripper bar and rear conveyer each swing through an arc of 45 deg from center providing flexibility in operation. The machine is propelled by two caterpillars.

With the ripper bar in retracted position, the machine is advanced on its caterpillars until the ripper bar touches the coal face in the center of the working place. The ripper is then swung to the right and positioned in accordance with the width to be mined. The ripper bar is then lowered to the floor and hydraulically advanced, horizontally, 18 in. into the coal. This advance into the base of the coal seam is known as sumping. At this point hydraulic pressure is applied upward, forcing the ripper bar through the coal to the top of the seam, after which it is retracted and lowered. While the ripper bar is lowered, it is also swung 30 in. to the left about the main turntable and readied for the sumping phase of the next stroke. The strokes are repeated until the desired width of mined area has been reached, at which time the ripper bar is returned to the center of the place and the machine is advanced 18 in. straight forward on its caterpillars. The cycle of strokes is then repeated.

The major operating units are electrically driven. Direct 7½-hp motor drives are applied to each caterpillar and to the 15-gpm hydraulic pump. Two 5-hp motors drive the rear conveyer and two 65-hp motors drive the chains on the ripper bar. A drive is taken from one of the ripper-bar motors to power the intermediate conveyer. Power from the hydraulic system is used to position the ripper bar and move it through the various portions of its cycle. Hydraulic power is also provided to lift the cleanup shovel, to lift the rear conveyer, and to elevate the timbering jacks.

The ripper bar is 30 in. wide. It may be lowered to operate 5½ in. below a level mine floor and raised 66 in. (100 in. for the high model) above a level floor. It is equipped with six chains, each containing 20 replaceable bits.

Two double-acting hydraulic roof jacks are located ahead of the operator. They may be used either directly to support the roof or to hold a crossbar timber against the roof while posts or jacks are set up under the timber ends.

The over-all height is 34 in. for the low-model and 48 in. for the high-model machine. The length of the machine is 25 ft 6 in. and its width 7 ft 6 in. It can drive a place with width ranging from 10 to 17 ft. The low model operates well in seams from 40 to 60 in. thick, whereas the high model operates in 54 to 96-in. seams.

The Joy Continuous Miner is designed to mine two tons of coal per minute. However, the actual speed with which coal can be mined varies with the characteristics of each seam and of every mine in that seam. It also varies with the efficiency of the transportation system in hauling the coal away. It is said that the Miner has already proved successful in the Colorado Laramie lignite seam, the Pittsburgh seam, the Freeport seams, and the Illinois No. 6 seam. In the Colorado lignite seam, the Continuous Miner is said to have virtually eliminated the need for timbering.

Steel

DESPITE all-time weekly production records, the steel shortage continues, an article in the *Industrial Bulletin* of Arthur D. Little, Inc., points out. The immediate forecast is for worse conditions, as demand continues to rise; for the longer term there is hope of greater output from existing facilities, through technical advances, and of lower cost in relation to general price levels. Currently the most promising means of increasing iron output is pressure operation of the blast furnace. Various methods of improving ore quality will probably not raise output, but will prevent a drop as good ore supplies are depleted. Oxygen will soon be used to increase the steel output of open hearths, and it may also boost iron production in the blast furnace.

Today the blast furnace is the steel industry's key operation, the article states. Using coke and limestone, it converts iron ore into pig iron, most of which is then refined into steel in the open hearth. Since open-hearth capacity usually keeps up with iron output, the emphasis is on increasing blast-furnace productivity, which has dropped generally ten per cent in recent years. This is usually attributed to poorer coke and ore with less desirable physical characteristics. The capacity of a furnace depends on the iron content and other characteristics of the ore fed to it, the quality of its coke, and the time required to reduce the ore to iron, which in turn depends on the amount of air which can be blown into the furnace without blowing too much of the charge out the top.

By operating the furnace at top pressure of ten pounds or more, instead of the conventional two or three pounds, more air can be packed into the furnace, and it can be kept there longer. The result is faster reduction of the ore, giving at least a ten per cent increase in daily output, and a substantial reduction in coke costs. One company, Republic Steel Corporation, has converted five furnaces to pressure operation, and will shortly convert another two. The seven furnaces represent 45 per cent of the company's total pig-iron capacity. Reported increases in output of these furnaces have ranged up to 25 per cent. Although some of the largest furnaces would require new blowers to provide enough air for optimum pressure operation, a recent survey showed that 40.5 per cent of the U. S. blast-furnace capacity could be converted to pressure operation without important new equipment. This increased output would total over four million tons annually. For several years, ores have been improved at the mines by washing out or otherwise removing some of the extraneous material, to keep the iron content up to standard. More such treatment will be needed as poorer ore is used, but the cost is much greater than for removing good ore from an open pit. According to the article, Carnegie-Illinois Steel Corporation reported an experiment at its Edgar Thompson Works at Braddock, Pa., with more drastic treatment whereby fine particles of ore were agglomerated to larger pieces, and all materials were carefully sized and selected, to obtain a burden which handled much better in the furnace. Production increases up to 20 per cent, with reduced consumption of coke and limestone, were obtained, but the cost of building the facilities for such treatment on a large scale may not be justified. The Kaiser furnace at

Fontana, Calif., uses a high-grade ore treated in similar manner, and reports outstanding furnace productivity.

The air blown into a blast furnace is important chiefly for its oxygen, and there has been considerable discussion of enriching the air with oxygen. It has not yet been tried on a production scale in the United States, but experimental runs have been made. Optimistic reports have come from the experimental work with ferroalloy blast furnaces in Germany and the Soviet Union.

In the open hearth, oxygen mixed with the air stream to the burners has been widely accepted as a means of reaching higher temperatures to melt the scrap used with pig iron to make steel. Oxygen has also been bubbled through the molten metal to help burn out the carbon. Production increases of ten to thirty per cent have been reported. Oxygen enrichment of the blast also raises the steel output of the Bessemer converter by comparable amounts. Use of oxygen is now practical because wartime advances will reduce its cost, perhaps to $5 a ton, a fraction of the prewar figure. Oxygen plants capable of handling several open hearths are being or have been built for Weirton Steel Company, Bethlehem Steel Company, and Wheeling Steel Corporation. Other steel companies also are experimenting with use of oxygen in the open hearth.

In the light of these developments, the article states, tomorrow's steel plant is expected to differ substantially from today's, both physically and in operating techniques. Blast furnaces will probably withstand pressures considerably higher than the range thus far explored. Much larger turboblowers will replace the miscellany of gas- and steam-driven reciprocating engines now used. An oxygen plant will be standard. Raw materials will be carefully prepared, and new methods of handling materials and products will be evolved to meet greater production. Tomorrow's plant, without being larger physically, it is stated, may double the output of its present counterpart.

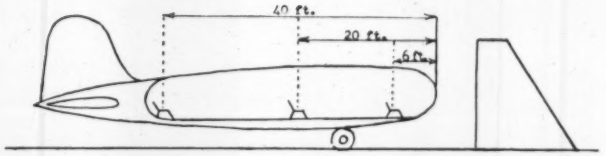

FIG. 3 MOCK-UP OF A TROOP TRANSPORT GLIDER WITH DIMENSIONS

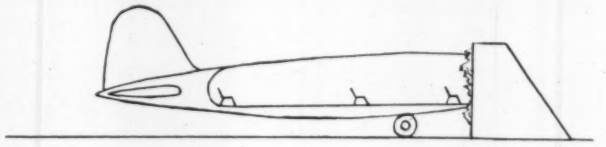

FIG. 4 20-MPH CRASH—4 FT OF STRUCTURAL COLLAPSE—3.3 g DECELERATION

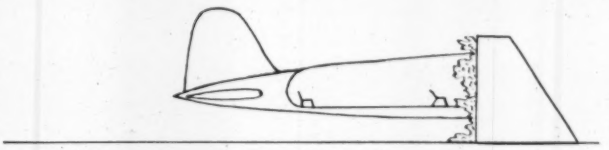

FIG. 5 40-MPH CRASH—16 FT OF STRUCTURAL COLLAPSE—3.3 g DECELERATION

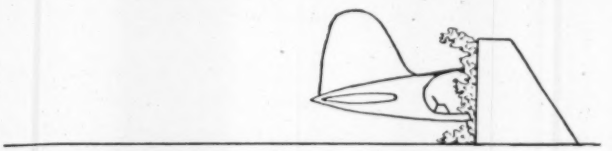

FIG. 6 60-MPH CRASH—36 FT OF STRUCTURAL COLLAPSE—3.3 g DECELERATION

Crash Injury Research

AIRCRAFT crash deceleration, crash energy and their relation to crash injury are now under study by the Crash Injury Research group of Cornell University Medical College, New York, N. Y. According to this group the interrelationship of forces in a crash leads to considerations of relativity that make it difficult to express crash factors in terms commonly used in physics. With due respect to the dangers of oversimplification, however, a crash can be regarded as fundamentally a manifestation of energy absorption by collapse of aircraft structure.

As kinetic energy increases with the square of velocity, the threshold of uncontrollable crash danger for the occupants of an airplane is reached when total crash energy exceeds the total energy-absorbing ability of aircraft structures that intervene between the occupants and impact areas. In many aircraft accidents the total kinetic energy is insufficient to demolish the cabin and, in such crashes, the possibility of crash protection is shown by repeated accidents of great severity in which people are not injured.

The relationships of crash force, crash energy, impact, deceleration, and "kinetic loading," and their efforts on crash injury can be correlated in many accidents. These relationships are frequently very complex; they can, however, be observed under the comparatively simple conditions that exist in some accidents in which the principal crash forces act in parallel relationship to the aircraft structure. The most important of these relationships are shown in Figs. 3, 4, 5, and 6.

Fig. 3 indicates a mock-up of a troop transport glider or other large aircraft. At three positions in the cabin, which might be 42 ft long, seats can be fastened, one 6 ft from the nose, one 20 ft from the nose, and the third, 40 ft from the nose. In the seats three passengers could be held by strong safety belts. For experimental purposes the structure of the cabin would be of some fragile material such as light metal or plywood which would crumple progressively and uniformly if a force were applied to the nose sufficient to cause an acceleration or deceleration of 3.3 g in the cabin.

If this mock-up were rolled down a long incline into a solid concrete obstruction at 20 mph, the forward end of the cabin would be crumpled and telescoped through a distance of about 4 ft in absorbing the energy of the 20-mph "crash" (see Fig. 4). At the extreme forward end of the fuselage, and especially in the area where the velocity of nose structure was changed from 20 mph to zero "instantaneously," structures would be subjected to impact force of a magnitude that would surely cause human injury. But except for the collapsed area at the nose, the cabin would remain intact and would be exposed to a deceleration of only 3.3 g during the absorption of energy. The force transmitted to and acting on the passengers in the cabin would be controlled and limited in this crash to 3.3 g—the maximum force that the cabin structure could withstand and transmit to the safety belts. Persons occupying rearward seats in the cabin would be uninjured because they would escape: (1) A deceleration exceeding the tolerance of the human body; (2) impact with forward wreckage or obstructions; (3) involvement with collapse of surrounding structure in areas not subjected to impact; and (4) being thrown against dangerous structures inside intact portions of the cabin.

If the cabin were rebuilt and the experiment repeated at double the velocity, Fig. 5, the crash energy would be quadrupled and about 16 ft of forward section would collapse during absorption of the energy of the 40-mph "crash." Obviously, the cabin would not decelerate materially before the first seat hit the obstruction; the person in the nose of the ship therefore would be subjected to impact injuries in addition to crushing injuries resulting from involvement with collapse of surrounding structure. However, in this same crash, the person sitting amidships and the person in the seat at the rear end of the cabin would be subjected to a crash deceleration of only 3.3 g (for a fraction of a second longer than in the 20-mph crash).

If the experiment is again set up and repeated at 60 mph, Fig. 6, the kinetic energy will again increase with the square of the velocity and 36 ft of the cabin would be destroyed in absorbing the crash energy. In this case the person in the foreward seat would "hit" at almost full crash speed and injuries from striking the solid obstruction at this speed would be extreme; the seat amidships would pile up on demolished structures and the exposure to injury due to impact with forward wreckage and collapse of surrounding structure would be very severe. But the occupant of the rear seat still would be exposed to only a brief deceleration of 3.3 g—and the exposure to injury would be no greater than in previous experiments.

A crash deceleration of 3 g is insignificant in terms of human tolerance of brief force. German experiments have shown that a deceleration of 20 g can be tolerated without injury by use of a safety belt alone. In the development of ejectable seats for fighter aircraft it has been demonstrated that vertically acting accelerations of 20 to 30 g can be tolerated without material discomfort or danger. In cases of free fall, people have survived without serious injury when the body has been properly supported during brief decelerations of 100 to 200 g.

Study of accident and injury details in many crashes give evidence that: (1) The magnitude of peak force and the mean crash deceleration transmitted to occupants of intact portions of the cabin are governed and limited by the strength of intervening structures; (2) longitudinally acting crash forces transmitted by intact structure to the occupants of small airplanes of conventional design do not exceed the limits of human tolerance of force; (3) the total energy of a crash determines the extent of structural failure and governs injury exposure in areas of impact and structural collapse; and (4) the magnitude of crash energy, not the magnitude of crash deceleration, is the major danger in most light-plane accidents.

It is emphasized that the rate of serious and fatal injury can be cut in about 60 per cent of the accidents in private flying by developing spinproof aircraft with safer correlations between minimum safe flight speeds and the energy-absorbing capacities of aircraft structures.

In reviewing the crash injury details of actual accidents in the light of the theoretical crashes, it becomes apparent that the strength and amount of structure between the occupants of a small airplane and impact areas governs (*a*) the total amount of crash energy that can be absorbed before the occupants are endangered by structural collapse, and (*b*) the magnitude of crash deceleration to which the occupants will be subjected. Crash results in present-day light airplanes provide evidence for previous statements by the Crash Injury Research project that danger in many accidents is dictated when the ship is built.

It has been said that if the front seats of automobiles were on the front bumpers, the rate of fatality in motoring would greatly exceed the present rate of injury and fatality in private flying. It may be stretching things a little to visualize the front seat of a car on the bumper, but the concept does serve to emphasize the extent to which the dangers of motoring and flying are governed by the relationship of the occupants to structure.

The Cornell group emphasizes that a major increase of safety is necessary before aircraft can be widely accepted for family users. Errors of judgment by inexperienced pilots with resultant injuries and fatalities have hurt the expansion of private flying and affected every branch of aviation adversely. The dangerous gap between minimum safe flight speeds and the energy-absorbing capacities of light airplane structures will continue to be the foremost danger of popular flying until bridged by improved design, the group states.

It is pointed out that structures designed for greater energy absorption and controlled deceleration in conjunction with shoulder harness and more effective safety belts will cut crash dangers in private aircraft which, up to the present, have been virtually unchallenged by aircraft engineering.

Reflectoscope

A SPERRY ultrasonic reflectoscope that enables engineers to examine solid pieces of steel by means of sound waves is being used by the Westinghouse Electric Corporation to assure flawless quality in their giant electric generators.

With this new technique, ultra-high-frequency sound waves are transmitted through massive steel parts. By using a crystal similar to that used in most phonograph pickup arms, electrical impulses are changed into sound waves. When projected through the metal, tiny cracks, cavities, or foreign particles in the metal reflect sound waves back to the crystal. Such reflections, changed back into electrical impulses, appear as bright vertical lines on the viewing screen of an electronic receiver.

By measuring the time it takes the sound waves to go through the metal and bounce back to the crystal, metallurgists can find the exact location of any flaw. When the metal is flawless throughout, the sound waves reflect from the opposite side of the object. The reflected sound is said to reveal the quality of metal as accurately as an x ray while penetrating thicknesses that x rays cannot reach.

The new testing process is called ultrasonic instead of supersonic because supersonic refers to speeds faster than sound, whereas ultrasonic refers to sound waves at frequencies beyond the range of human hearing. The ultrasonic process is based

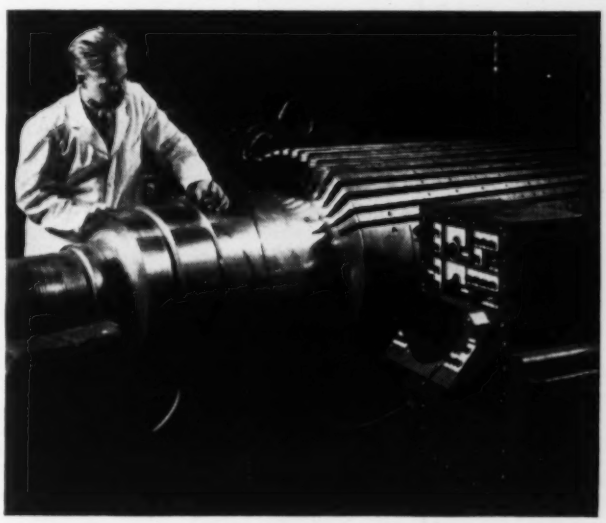

FIG. 7 ULTRASONIC REFLECTOSCOPE BEING USED TO EXAMINE NEW GENERATOR ROTOR BEFORE IT IS PUT INTO OPERATION

on the same principle as radar. Radar projects radio waves through the air, but the high-frequency sound projector sends waves of sound through solid metal.

In addition to testing generator rotors, the ultrasonic technique is used for testing other metal parts ranging in size from 0.025 in. to 30 ft thick. X ray is practical only for metal thicknesses up to about 6 in.

New England Power

A RECENT report of the Power Survey Committee of the New England Council, Boston, Mass., entitled, "Power in New England," examines the existing power situation in New England, forecasts the probable growth of power demand over the next decade, and indicates the increase in generating capacity which will be necessary to meet the probable demand.

Since 1920, while the population of New England has increased about 20 per cent, the output of the electrical utilities has increased about 400 per cent, the report indicates. In the same period, however, the increase in generating capacity has been only slightly more than 200 per cent. This became possible through improved load factor, multiple-shift operation in industry, more efficient use of reserve capacities, and especially dependence upon a system of interconnected transmission (except as between Maine and the rest of New England) which had been built up over the years. In Maine, where the export of hydroelectric power is prohibited by law, there is similar interconnection of generating plants within the state so that surplus capacity at any plant is made available wherever power is needed. During the war, it is pointed out, construction of power-generating plants was at a virtual standstill, so that continued heavy postwar demands gave the utilities a particularly difficult problem during the period of drought in late 1947 when the margin of safety between capacity and load was perilously low.

The study foresees the need for an increase in New England's generating capacity of about 1,100,000 kw during the next 10 years. This means the construction of about 110,000 kw capacity a year. The capacity of plants now under construction is deemed sufficient to meet the anticipated demand of the immediate future.

It appears that most of these new generating plants to be built in New England, outside of Maine, must use fuel as a source of power. The total potential capacity of undeveloped water power in New England deemed practical to develop under suitable load conditions is about 420,000 kw, and of this amount the undeveloped Maine water powers (which cannot be regarded as available except in Maine) constitute 263,000 kw. But even if all these undeveloped water powers were available and near enough to market, their complete development would supply only about one third of the anticipated increase in New England demand over the next decade. Only in Maine can water power be considered as an important source of new power in the near future. The effective capacity of existing water powers in Maine in firm year-round power will be increased substantially by additional storage reservoirs under construction and projected.

This study presents facts and figures which show that New England water power, except in the state of Maine, has become of small importance as a basis for future industrial development or as a potential source of power for any purpose. Hydroelectric power is cheap only in the most favorable locations, of which few remain undeveloped, and of all the industries of New England using electric power, perhaps the only one to which the cost of power might be a determinant factor in its location is the pulp-and-paper industry.

Public attention has been directed to the St. Lawrence seaway and power project as a possible source of power for New England. This study indicates that the growing power demand in upper New York State would probably absorb all the power from this source as fast as it could be developed. New England should not rely upon the St. Lawrence as a potential source of power.

At certain of the flood-control projects planned in New England by the Corps of Engineers, United States Army, water power plants may be included. At these so-called "dual purpose" projects, generating capacity to the amount of 80,000 kw, might be installed.

In Maine, the Passamaquoddy project is still being discussed. No doubt power can be generated from the tides there, if anyone can be found who will pay the cost. About 12 years ago the Federal Power Commission estimated the cost of construction of the smaller "American Project" at about $1090 per kw. At that time hydroelectric power was costing around $250 per kw to build, and steam power about $100 per kw. Until such time as a complete engineering study establishing the economic soundness of the Quoddy project is made, no public funds should be appropriated for its construction.

The study shows that, except in those industries using process steam, manufacturing establishments are depending more and more upon the utilities for their power supply.

With minor exceptions, in developing new power-generating capacity, advantage has been taken of every improvement looking toward the reliability of supply and operating economy. The study makes reference to the high-temperature high-pressure steam plants now in service or projected, to the mercury-steam station now being built at Portsmouth, N. H., and to projects involving gas turbines now under construction.

Radioactive Tracers

AN application of war-born nuclear fission to speed up improvement of automotive fuels and lubricants was announced jointly by California Research Corporation, Standard Oil Company of California's research organization, and the Isotopes Division of the Atomic Energy Commission.

This company is using a revolutionary research method involving the use of radioactive automotive parts in test engines. Its eventual result probably will be expressed in longer engine life and less money spent by the average motorist for automotive repair, as well as more economical automobile operation.

In the new test method, the company has worked closely with the Atomic Energy Commission, using piston rings which have been suitably activated in an atomic pile at the Oak Ridge National Laboratory.

This peacetime application of nuclear fission to modern industry has enabled the research engineers to run fuel and lubricant tests in a much shorter time than present methods permit.

In beginning a typical fuel or lubricant test, a radioactive piston ring, for example, is taken from its 300-lb lead safety box and carefully placed on the test engine's piston. Then, after three or four hours of operation, a sample of oil is taken from the engine's crankcase. The oil is tested with a delicate Geiger counter which immediately indicates the amount of metal worn from the activated ring—minute particles of iron flushed away by the oil.

With radioactive rings in a test engine, the amount of wear can be measured so closely that as little as one millionth of an ounce of metal worn from the rings can be detected.

Two other oil-industry uses of radioactive substances also were revealed by the Research Corporation and the AEC.

One involves the tracing of oil shipments through miles of pipe line, which is accomplished by placing one billionth of an ounce of radioactive barium in an oil sample, and then following the sample's progress with a Geiger counter. In this way it becomes possible to separate more accurately the many types of crude oil or products which flow one behind the other through a given line.

Another application is that of radioactive carbon, used in much the same way to learn more about what happens to gasoline molecules as they pass through the complex operation of a modern refinery. It is expected that this new scientific tool will contribute to the steady improvement in methods of producing better petroleum fuels, and in the more efficient use of the nation's oil resources.

Radioactive isotopes are being supplied by the AEC to many industrial concerns over the United States for experiments designed to obtain more efficiency in operations, improvement of products, and better use of materials. Since August, 1946, when the first formal shipment of radioisotopes was made from the Oak Ridge National Laboratory, 173 shipments have been made to industrial concerns for experimental work.

In addition, 4369 shipments have gone to researchers and laboratories in this country for experiments in biological, medical, and agricultural fields. Nineteen foreign countries have received 355 shipments for experimental work.

New Temperature Scale

ON Jan. 1, 1949, the National Bureau of Standards began using the definitions of the International Temperature Scale of 1948 both in its own research program and in calibrating instruments for other scientific and industrial purposes. Based on a draft prepared by members of the Bureau staff, the new scale was adopted at Paris, France, by the Ninth General Conference on Weights and Measures in October, 1948, and the official text was approved for publication before the end of the year. This is the first revision of the International Temperature Scale since its adoption 21 years ago. The experimental procedures by which the scale is to be realized are substantially unchanged; but certain refinements, which are based upon experience, have been incorporated to make the scale more uniform and reproducible.

The experimental difficulties inherent in the measurement of temperature on the thermodynamic scale (an ideal scale based on energy changes in a Carnot cycle) led to the establishment in 1927 of the practical scale known as the International Temperature Scale. This scale is based upon six reproducible equilibrium temperatures, or "fixed points," to which numerical values are assigned, and upon specified interpolation formulas relating temperature to the indications of specified standard temperature-measuring instruments. The scale is designed to conform, as nearly as practicable, to the thermodynamic Celsius scale, as it is now known (The Ninth General Conference decided to abandon the designation "Centigrade" and use "Celsius" instead). At the present time, however, it is possible to obtain values of temperature on the International Temperature Scale more accurately than on any thermodynamic scale.

The International Temperature Scale of 1927 proved useful in providing a stable, uniform, and precise basis for obtaining temperatures. However, since the adoption of this scale, the increasing precision attained in temperature measurements has made it apparent that some revision was desirable in order that measurements of physical constants—for example, the freezing and boiling points of pure compounds—might be made on a more exactly comparable basis by laboratories in all parts of the world. Because of the present leadership of the United States in the fields of heat and thermometry, the major responsibility for proposing and obtaining agreement on the changes fell to the National Bureau of Standards. After many consultations with scientists and laboratories in this country and abroad, the Bureau prepared a draft which formed the basis of the document finally adopted by the General Conference as the International Temperature Scale of 1948.

The six fixed points of the 1927 scale were the boiling point of oxygen (—182.97 C), the freezing and boiling points of water, the boiling point of sulphur (+ 444.60 C), the melting point of silver (+ 960.5 C), and the melting point of gold (+ 1063 C). From —190 to +660 C, the measure of temperature was based on the indications of a standard platinum-resistance thermometer used in accordance with specified formulas. From +660 C to the gold point, a platinum-platinum rhodium thermocouple was the reference instrument; and above the gold point, the optical pyrometer has been standard.

The same fixed points, with one slight modification, are specified in the 1948 scale, and the laboratory procedures for obtaining temperatures between fixed points are essentially the same as those previously used. Only two revisions in the definition of the scale result in appreciable changes in the numerical values assigned to measured temperatures. One of these is the change in the value for the silver point for 960.5 to 960.8 C, which affects temperatures measured with the standard thermocouple. Thus in the range between 630 and 1063 C, numerical values of temperature are higher than on the 1927 scale, the maximum difference being about 0.4 deg near 800 C. The adoption of a new value (1.438 cm-deg) for the constant c_2 in the radiation formulas changes all temperatures above the gold point. In the new scale, Planck's radiation formula is specified instead of Wien's for calculating temperatures above the gold point as observed with an optical pyrometer. Since Planck's law is consistent with the thermodynamic scale even at high temperature, this change removes the upper limit to the scale formerly imposed by the use of Wien's law.

There are several other important modifications in the scale which cause little or no change in numerical values for temperatures but serve to make the temperatures more definite and reproducible. For example, the standard platinum-resistance thermometer is to be used as a reference instrument from the oxygen point to the freezing point of antimony (about 630 C), rather than over the range from —190 to +660 C. Platinum of higher purity is also specified for the standard resistance thermometer and standard thermocouple, and smaller permissible limits are given for the electromotive force of the standard thermocouple at the gold point.

Stratovision

ACCORDING to an article in *The Martin Star*, February, 1949, the major technical problems in the use of Stratovision as an air-borne method of broadcasting television and frequency-modulation programs have been solved, and the system is ready for commercial development.

Walter Evans, vice-president, Westinghouse Electric Corporation, speaking for both Westinghouse and the Martin Company, codevelopers of Stratovision, stated that extensive flight tests over a three-year period show that Stratovision is a practical and useful method of expanding television service, and provides a wide variety of functions in relaying television and other high-frequency communications.

He pointed out that the commerical development of Stratovision awaits the crystallization of public demand for the expanded services offered by air-borne broadcasting, application of the system by the radio industry to meet this demand, and

the clarification of channel facilities available to make possible this application.

Although final flight tests in the current Stratovision phase are approaching completion, Mr. Evans explained that development of relaying and broadcasting equipment incorporating the information realized during the flight-test period will continue. In addition, propagation studies for commercial application will be compiled, and developmental engineering for standardizing air-borne broadcast equipment will be started.

A complete report on the engineering development of Stratovision, commercial applications, and frequency allocation programs for air-borne broadcasting is being prepared by Westinghouse. It is intended to make it available to interested groups in the radio, television, and communications industries.

The preliminary report stated that there are no "technical restrictions which will prevent the use of Stratovision broadcasting to provide:

1 A coast-to-coast network for regular television and frequency-modulation programs.

2 Expanded television coverage for the millions of rural listeners who will be unable to receive television programs for years, if ever, with conventional television broadcasting methods.

3 A military communications system independent of ground conditions.

4 A network for communications systems utilizing high frequencies.

5 A network system for transmitting television programs simultaneously to audiences assembled in theaters or other public places throughout the country.

6 A television network to meet military reconnaissance observance and transmission needs."

Planing Wood

THE technical aspects of planing wood were explained by Peter Koch, assistant to the president, Stetson-Ross Machine Company, Seattle, Wash., at a Wood Industries Division technical session during the 1948 ASME Fall Meeting in Portland, Oreg.

He pointed out that in the primary lumber manufacturing process of planing there is a threefold objective: First, to obtain a maximum quality of finish; second, to establish a maximum accuracy of dimension; and third, to manufacture at a maximum of economy.

QUALITY OF FINISH

There are four factors to which surface defects may be traced. First, moisture content, grain characteristics, and general machinability of the wood; second, the knife and cutterhead characteristics; third, the feed characteristics; and fourth, machine characteristics.

ACCURACY OF DIMENSION

Two general factors are involved in the accuracy of dimension obtainable in lumber-planing machines—the lumber characteristics and the machine characteristics. Mr. Koch concentrates on the machine characteristics with special emphasis on the head arrangement, a comparison being made between the two-way thicknessing planer and the conventional one-way thicknessing planer.

In the conventional cutterhead arrangement, Fig. 8, the pressure in the lumber passing through the planer is exerted downward—forcing the stock against the lower bed line first. The effect is as follows:

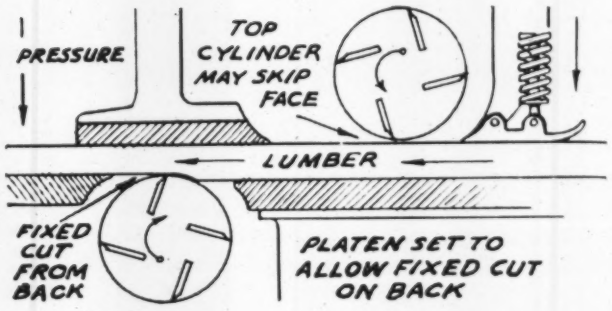

FIG. 8 ONE-WAY THICKNESSING PLANER HEAD ARRANGEMENT

1 The top cylinder must remove the excess thickness, if any, to produce a finished face. The lower cylinder then takes a fixed cut from the back or lower side of the lumber regardless of whether the face has been surfaced or not.

2 If the stock is too thin to be surfaced on the face, it will be made still thinner by the cut from the lower cylinder—causing unnecessary waste.

3 Because the upper cylinder cuts while the lumber is still rough on the back, it may produce a wavy surface on the face.

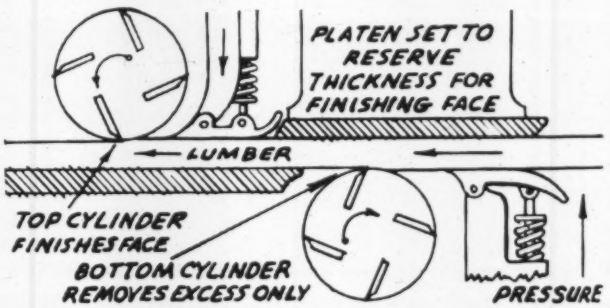

FIG. 9 TWO-WAY THICKNESSING PLANER HEAD ARRANGEMENT

On the two-way thicknessing planers, Fig. 9, the bottom cylinder cuts first, and pressure is exerted upward against the top platen which is solidly locked in a position which reserves the thickness necessary for surfacing the face, face up, afterward. Two-way thicknessing planers operate as follows:

1 A varying unmeasured cut, heavy only if stock is thicker than necessary, is taken on the bottom cylinder against a solid overplate, i.e., the lumber is measured and thicknessed, first from the back against a solid plate above. Thus the surplus stock, if any, is taken from the heart, or low-grade side of stock having a face side.

2 After the lumber passes the bottom cylinder, it is flexed or pressed down by the top chip breakers, its prethicknessed back being against the bed under the top cylinder, and is finally and perfectly thicknessed from the face by the top cylinder. Again, the board, not the cut, is measured.

ECONOMY OF OPERATION

The selection of adequate planing machines for economical operation depends upon the following characteristics: High utilization of material, high rate of output, versatility of setup, ease of maintenance, simplicity and safety of operation, and initial cost compatible with rate and quality of output.

In considering utilization of material Mr. Koch states that

there is no more lumber-saving principle of planing wood than by the two-way thicknessing method. In long-term tests of the two-way thicknessing process it has been proved that, compared to conventional planing methods, it is possible to saw lumber no less than 3 per cent thinner than standard practice, and still maintain a quality and grade of output superior to the conventional machines. This 3 per cent saving in stock is further bolstered by the upgrading of intermittently underthickness stock and by the advantage of highly accurate thicknessing.

However, a major problem remains in the disposal of the chips. While in some planing mills these chips are utilized for briquettes, the machinery has yet to be developed for use by small operators. A small-scale integral briquetting machine to take the place of the intricate and horsepower-consuming blower system so common to the modern planing mill, possibly will be developed.

Perhaps the factor foremost in most superintendents' minds is the problem of speed rate of output. It may well be said that the conception of the lumber package and the development of efficient infeeding equipment has done more to speed up the lumber-planing process than any other single factor since the inception of jointing.

Although much has been accomplished to reduce the machine down time due to grinding and jointing, there is a great deal yet to be developed. The application of carbide-tipped knives will no doubt become more widespread and may be expected to drastically reduce the time consumed in both the grinding and jointing process.

As the refinement of machine design proceeds, the accent shifts from speed to versatility. Operators are interested in a machine's capacity to run a multiplicity of patterns with a minimum of down time. Notable among the comparatively recent developments along this line is the use of push-button-controlled motors to hoist the top rolls, cylinder, and profiler, and to traverse the outside head.

Ease of maintenance is of considerable importance in the selection of any machine. Individual motors have largely replaced belts, push buttons are replacing hand cranks, ball bearings continue to replace babbitt bearings, and breakdowns of expensive machinery have been minimized by sealed-in splash lubrication of important moving parts, replacing unsealed grease lubrication. It is to be expected that central lubrication and pressure oiling systems will soon be in the picture.

A major current trend is toward simplicity and safety of operation. Machine designers are gradually thinning out the number of men necessary to the operation of a planing mill. A few highly trained operators and a grinding-room specialist have, in modern operations, supplanted the horde of semiskilled and unskilled workers that surrounded the old-time planer and matcher. While the planing mill is, and always has been, a place of high occupational hazard it need not continue to be so. Perhaps the design improvement longest overdue in this respect is the development of an effective method of soundproofing the high-speed planer and matcher.

The extreme temperature fluctuation in northern-latitude mills necessitated by the customary open-planer-shed construction; the high rate of air exchange occasioned by the intakes to the blower system; and light and color conditioning also should be given attention.

Autopilot

THE Navy's latest contribution toward solution of the all-weather flying problem is a new autopilot capable of flying a large transport through "dirty" weather and then automatically setting it down on a runway. A Douglas twin-engined Navy R4D-6 transport has been equipped with the "angle of attack autopilot," as the device is officially designated, for more than a year and a half. Angle of attack is defined as the angle between the wing and the line of flight. A description of the autopilot appears in the CADO *Technical Data Digest*, Feb. 1, 1949.

Although the autopilot still is in the experimental stage, it has been successfully demonstrated. Stallproof, the system controls the plane automatically at high or low air speeds, in any condition of loading, and guides the craft on a beam to a complete touchdown on the runway. This new device is unique in that the power delivered to the engines is controlled by an element which is sensitive to the angle of attack. Control surfaces are automatically operated in a manner much like that of a conventional autopilot because gyroscopes still provide the initial sensing of roll and pitch.

The angle-of-attack control makes use of the fact that an airplane's stalling point is dependent, not on its air speed, but on its angle of attack, which in turn is dependent on the shape of the airfoil. As an aircraft is more heavily loaded or subjected to additional g's, the stalling speed increases but the angle of attack at which the ship stalls remains constant.

Within a given range of angles of attack, any plane may be made to climb, glide, or cruise, by increasing or decreasing power. This new autopilot, however, controls the power settings to conform with the desired flight path of the airplane and because it is sensitive to the ship's angle of attack which determines its stall point, it provides virtually foolproof stall characteristics, regardless of whether the plane is in a turn, glide, climb, or in level flight.

Landing approaches can be made at an air speed of between 70–75 knots, depending on the loading and desired angle-of-attack setting. This is comparatively slow but is, nevertheless,

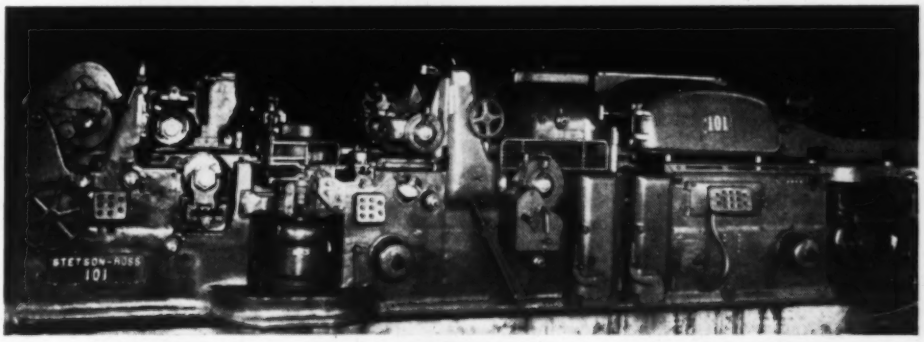

FIG. 10 MODERN HEAVY-DUTY TWO-WAY THICKNESSING PLANER AND MATCHER

routine for the autopilot. The experimental device weighs 140 lb but as yet the Navy has made no effort to reduce its size or weight.

Prone-Position Pilot Bed

A PRONE-POSITION pilot "bed" which greatly reduces the possibilities of blackout for pilots and materially lessens fatigue on long flights, has been developed by the U. S. Air Force.

During centrifuge tests in the bed, pilots have withstood gravity pull up to 12 times the force of their normal weight, or 12 g, while the conventionally seated pilot can tolerate only about 4.5 or 5 g.

Increasing a pilot's resistance to blackout in modern high-speed jet-propelled aircraft is of great importance to the Air Force. The prone position requires less space for the cockpit and permits the development of aircraft with slimmer silhouettes, thus permitting higher speeds by reducing fuselage drag.

The prone-position pilot bed was developed by the Aero-Medical Laboratory of Air Materiel Command at Wright-Patterson Air Force Base, Dayton, Ohio. It was described by Dr. H. T. E. Hertzberg of the Aero-Medical Laboratory, who spoke on "Anthropometric Data in the Design and Operation of Machines and Equipment," at the final session of the Human Engineering Seminar held at the Special Devices Center, Office of Naval Research, Sands Point, Long Island, N. Y., on February 8.

Pilots participating in recent tests experienced no discomfort from lying on the bed for as long as eight hours continuously. Reports indicated that in all cases they experienced less fatigue than from sitting in the normal flying position for a similar period.

The prone-position bed has not been made a standard part of any aircraft but has been installed in the nose of a B-17 Flying Fortress for test purposes. It will be tested soon in the forward part of a jet-propelled Lockheed F-80 Shooting Star. Both airplanes permit the use of conventionally seated pilots who can take over the controls in emergencies.

The bed consists of a length of nylon netting supported over specially curved sides to conform as closely as possible to the body contours of the pilot resting upon it. The mesh has extremely high strength characteristics and will support approximately 3400 lb per sq ft. In actual tests the bed has withstood a static load of 16 g assuming the weight of the pilot as 200 lb. In dynamic centrifuge tests it has withstood up to 20 g with a dummy.

Abdominal support can be adjusted to individual requirements by raising or lowering the netting under the abdomen in $^3/_4$-in. steps. The tests indicated that slender pilots with flat abdomens required greater support to keep the lumbar region of the spine from sagging. Controls are being set up so that pilots will be able to make the adjustments themselves as the need arises during flight.

Special airplane controls have been designed for the prone position. Two movable pans with adjustable handgrips act as the levers for steering the plane. They are padded with foam rubber to provide restful comfort for the arms during flight, and they are arranged mechanically so that control movements are not affected by high g forces.

To avoid the tendency of the inner surfaces of the legs to perspire, and to prevent pressure on the inside of the knees, the bed is equipped with a leg-separator board which gives each lower leg its own support.

Feet are braced against pedals which can serve as rudder or brake controls. The pedals can be moved to accommodate varying heights of pilots.

FIG. 11 PRONE-POSITION PILOT BED IN WHICH PILOT LIES DOWN WHILE HANDLING AIRPLANE CONTROLS

Static tests have indicated the great comfort of the prone-position pilot bed, and tests are now being carried out in the B-17 to study pilot reaction under actual flight conditions. Since the main complaint of pilots during the eight-hour static test was that they were bored, Aero-Medical Laboratory officials are of the opinion that the prone-position bed can be tolerated for much longer periods during actual flight conditions.

Australian Automobile

THE development of the first Australian automobile was discussed by Wesley M. Oler, director of public relations, General Motors Overseas Operations, at a recent ASME Metropolitan Section meeting held in the Engineering Societies Building, New York, N. Y.

Mr. Oler related that General Motors entered the automobile industry in Australia in 1926, establishing assembly plants in the five major cities, Brisbane, Sydney, Melbourne, Adelaide, and Perth. In these plants it has assembled American car and truck chassis shipped largely from its Canadian operations, and English vehicles from its Vauxhall and Bedford plants in Great Britain. The bodies for the passenger cars, however, were formerly built by and purchased from the Holden's Motor Body Builders Ltd. in Adelaide. In 1931 General Motors Australia Proprietary Ltd. took over Holden's Motor Body Builders, and the name of the company was changed to General Motors-Holden's Ltd. The new Australian car bears the name Holden.

The total market in Australia for cars and trucks of all makes approximates 100,000 vehicles a year, largely from American, Canadian, and English sources, as compared, for example, to more than four million here in the United States, Mr. Oler said.

The capacity of the manufacturing facilities which have been established in Australia contemplates the production of 20,000 cars and companion utilities annually, operating on a one-shift basis. He pointed out that the unit cost of overhead on a volume as small as this is considerably heavier than is the case here at home where vehicles are produced in much greater quantities. Consequently, he said, we are unable to produce a car in Australia as cheaply as we would like, but even so, the

Holden is priced lower than most of the imported cars with which it is in competition.

In spite of the fact that Australia cannot at this time be regarded as a mass market, an expanding absorption of motor vehicles in Australia is anticipated because of its natural growth in population and its immigration which is being carried on at an increasing rate. Quite naturally, too, Mr. Oler stated, Australia has an eye to the possibilities of exporting this car someday in the future, particularly to such pound-sterling and other adjacent territories as New Zealand, South Africa, India, and Indonesia.

According to Mr. Oler, the first step in building a car in Australia was to make a complete on-the-ground survey to determine what specifications were required in a car specifically tailored to meet Australian conditions. This study disclosed that the car should be somewhat smaller than the American Chevrolet, but larger than the smaller European and English cars; that it should have more road clearance than the average car in order to negotiate the rough roads in the back country; that it should have better hill-climbing performance in high gear than the lower horsepower English cars; that it should be as dustproof as possible for a country of high winds and dust; that it should be extremely economical in fuel consumption, since Australia imports all of its petroleum products which are heavily taxed and severely rationed; and that it had to be light in order to gain the needed fuel economy, but extremely rugged to withstand wear and tear.

After much work and study a car was designed to meet these specifications, and three prototype cars were built and thoroughly tested at the General Motors Proving Ground, in Detroit, Mich.

When the pilot models had proved satisfactory in this country they were taken to Australia. In the meantime, the manufacturing plants had been designed, the machinery purchased and shipped to Australia, so that the plant facilities were well under way when the pilot models arrived.

An 86-mile test course was laid out, including every type of road condition which a car might reasonably be called upon to meet, and the prototype cars were driven over this course day after day, under controlled operation. Three more pilot models were built in Australia and subjected to the same rigid tests. In this type of controlled driving, each mile is equivalent to about 4 miles of ordinary driving. From time to time the cars were taken down, the parts inspected, and specification changes made as actual usage dictated.

The Holden car as finally produced is a 5-passenger, four-door sedan of 103 in. wheel base. The road clearance is $8\frac{1}{2}$ in., being approximately an inch greater than the conventional American car. The car weighs 2230 lb. The engine is a six-cylinder overhead-valve type with 3-in. bore and $3\frac{1}{8}$-in. stroke, developing approximately 60 hp. It has a fuel consumption of about 30 miles per U. S. gallon at 35 mph. Mr. Oler reported that the engine has fine acceleration and the car a top speed exceeding 80 mph. It is said to have extremely good vision and excellent roadability, holding the road at all speeds as well, if not better, than many of the heavier imported cars. It has excellent springing and is unusually rugged. The finish, both inside and outside, is plain.

FIG. 12 PRODUCTION LINE OF HOLDEN AUTOMOBILES

Low-Temperature Research

AN improved type of helium liquefier, designed by R. B. Scott of the National Bureau of Standards, is proving useful in a program of basic research on the properties of matter at extremely low temperatures, where many remarkable phenomena occur. An important feature of the new liquefier, resulting in greatly increased versatility, is a transfer siphon for delivering the liquid helium to an external receiver which can be easily modified to accommodate the experiment at hand.

The unique low boiling point of liquid helium (4.2 C above absolute zero under atmospheric pressure) makes it indispensable for low-temperature research, particularly in the region below 4.2 K. At ordinary temperatures, no pressure, however great, will liquefy helium, and free expansion through a throttle valve causes warming rather than cooling. However, if gaseous helium is first cooled to about 20 K, the expansion produced by continuous flow through a throttle valve will result in further cooling.

About 16 years ago, F. Simon devised a simpler method of liquefying helium, which is utilized in the present apparatus. He filled a strong thermally insulated container with helium at 150 atm pressure. After cooling with solid hydrogen to about 10 K, the compressed helium was allowed to escape through a throttling valve. When the pressure had reached atmospheric, the container was found to be more than half filled with liquid helium. This marked cooling effect may be explained in terms of the work done by the gas molecules remaining in the container as they push out the gas that escapes through the valve. The energy to produce this work is supplied from the internal energy of the helium, so that, as the expansion proceeds, the temperature of the gas left in the chamber falls. After the liquefaction temperature is reached, further expansion results in the liquefaction of a considerable fraction of the remaining gas.

The helium liquefier constructed at the National Bureau of Standards operates on the Simon principle, but it differs from the usual type of Simon liquefier in that the liquid helium is delivered into an external receiver. In most earlier Simon-type instruments, on the other hand, the experimental chamber was a permanent part of the liquefier itself, and no provision was made for withdrawing the liquid helium. The new liquefier delivers about 310 cc of liquid in a single expansion, sufficient for some experiments lasting as long as 24 hours.

The heart of the apparatus is a thick-walled monel chamber, designed to withstand a pressure of 4100 psi, within which the helium is liquefied. This chamber, together with an outer jacket containing pumped liquid hydrogen, is supported in an evacuated container by a tube of low conductivity, also used for filling and pumping the hydrogen jacket. The evacuated container is surrounded by liquid hydrogen in a sealed Dewar flask, which in turn is immersed in a Dewar of liquid air.

After all the inner parts of the apparatus have been cooled to liquid-air temperature by filling the hydrogen Dewar and the liquid-hydrogen compartment with liquid air, the liquid air is

removed from them and replaced with hydrogen. Pure helium is then admitted slowly to the high-pressure chamber and the pressure rise observed. When the pressure in the chamber reaches about 80 atm, the hydrogen container is refilled and pumping started to reduce the pressure over this hydrogen. As the temperature is thus lowered, the helium pressure is brought to a maximum, about 150 atm. When the temperature has been lowered to about 10 K, the helium is allowed to escape from the liquefier by expansion through a throttle valve at the end of a transfer siphon. This value is adjusted so that the pressure falls at a moderate rate, reaching atmospheric pressure in 5 to 15 minutes. When condensation conditions are reached slightly below the critical temperature (5.2 K), liquid helium forms in the high-pressure chamber and flows over through the siphon as the expansion proceeds. After the expansion is complete, any liquid remaining in the chamber is forced over by the introduction of more helium gas. The cold helium gas that is first released serves to precool the external receiver so that very little helium is lost during the transfer.

Temperatures are followed during operation of the liquefier by means of a gas thermometer having high sensitivity at low temperatures. The thermometer bulb is attached within the liquid-hydrogen jacket. The cryostat into which the liquid helium is transferred consists of a soda-glass helium Dewar surrounded by a Dewar of liquid hydrogen, which in turn is protected with liquid air.

The new helium liquefier promises to aid materially in several lines of low-temperature research now being pursued at the Bureau.

Second sound has been obtained at the Bureau through use of liquid helium produced in the new liquefier, and a project is now under way to study various aspects of second-sound propagation in He II. Unlike ordinary sound, second sound is generated thermally and can be detected only by temperature-sensitive devices. Therefore a recently developed pulse method is employed so that signals that would otherwise be difficult to detect are presented on an oscilloscope screen.

Delta-Wing Aircraft

THE USAF'S newest research aircraft, designated as the Model 7002 for identification purposes, is undergoing flight tests at Muroc, Calif., Air Force Base.

Designed and built by Consolidated Vultee Aircraft Corporation at San Diego, Calif., the Model 7002 features a Delta wing, the first aircraft of this type.

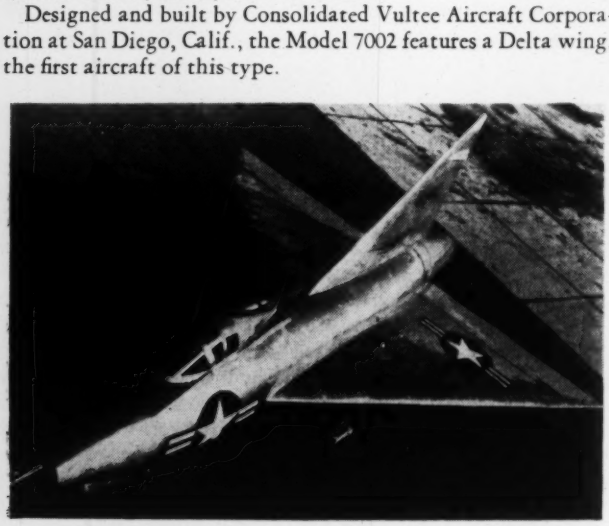

FIG. 13 NEW USAF RESEARCH DELTA-WING AIRCRAFT

The radically designed aircraft is being used to explore and test the stability and control characteristics of the Delta wing. This type of wing differs from conventional wings in that it has a much larger degree of sweepback—60 deg compared to the 35 deg which is the maximum now being used on Air Force aircraft. The wing is triangular-shaped and incorporates elevons in the trailing edge for aileron and elevator action, thus eliminating the need for a tail section. A vertical stabilizer and rudder are provided to give added directional control and stability.

Experimentation and evaluation of the aerodynamic characteristics of the Delta wing have been carried on in wind tunnels for several years, and these tests have indicated that the wing has low drag characteristics and satisfactory control in transonic and supersonic speed ranges.

The Model 7002 is powered by an Allison J-33 turbojet engine rated at 5200 lb thrust with water injection. It has a tricycle landing gear and a jettisonable bubble-type pilot's canopy.

Water Power

A NEW technical journal, *Water Power*, devoted to the study of all aspects of hydroelectric developments has recently made its appearance with the January-February, 1949, number. It is being published at Westminster, London, S.W. 1, England.

The first issue shows an attractive format, with dignified typography and make-up. It contains about 45 text pages, three fourths of which are devoted to feature articles. The departments, which make up the remainder of the magazine, include editorials, Editorial Notes, a section called From the World's Press and Technical Institutions, Contractors' Notes, and Science in Industry.

The following list of feature articles published in the first issue shows the type and scope of material the reader may expect: "The Power Resources of Europe," by T. G. N. Haldane, president of The Institution of Electrical Engineers; "The Assuan Dam," by Abdel Aziz Ahmed, chairman of the Hydro-Electric Department, Egyptian Government; "Civil Engineering Aspects," by Rolt Hammond; and "Developments of Intake Works and Surge Tanks," by Dr. Charles Jaeger. Other articles in this issue include: "Inauguration of the Scottish Scheme;" "Canada's Big Schemes;" and "The Karapiro Station, New Zealand."

If the content of this first number is an indication of the level of the editorial content of future issues, this new magazine should prove interesting and worth while to its readers.

Radiological Defense

THE U. S. Air Force has opened a six-week radiological defense course at Keesler Air Force Base, Biloxi, Miss., under direction of the Technical Division of Air Training Command, to train officers and airmen to deal with the effects of atomic or radiological attacks.

The first class was composed entirely of USAF personnel, but the second class includes students from the Air Force, Army, Navy, Coast Guard, and U. S. Public Health Service.

Normal student enrollment is about 40 per class, and a new class starts every seventh week. Instructors are USAF officers and civilian personnel with extensive backgrounds in physics and chemistry.

The curriculum of the radiological defense course was recommended and approved by the Atomic Energy Commission and is similar to that of Army and Navy schools now training

personnel in radiological defense duties. Instruction in the school varies somewhat because of the different missions and hence different types of equipment used in each service.

Radiological defense personnel in the Air Force are being assigned at all levels of command—from USAF headquarters down to each Wing in the USAF. Graduates of the course, upon returning to their units, prepare plans to deal with radiological problems which conceivably could confront their organizations. In addition they instruct other personnel in the use of Geiger counters, pocket dosiometers, film badges, and other instruments used to detect the presence of radiation or to measure the degree of individual radiological exposure.

Perhaps the most far-reaching effect of the radiological defense course will be to spread knowledge through the Air Force of methods and techniques which would combat radioactive particles and the tissue-destroying radiation emitted by these particles.

Gallium

GALLIUM, a rare silvery-white metal of unique properties, is now being produced and sold by Aluminum Company of America. This unusual metal is liquid on a warm summer day (melting point, 86 F), but it will not boil until heated to approximately 3700 F. Gallium shows a strong tendency to undercool, and the liquid metal may be held for some time at temperatures almost as low as the freezing point of water without solidification taking place. Though similar to aluminum in its chemical behavior, gallium is not a light metal. Its density (5.9) is about twice that of aluminum, but only about half that of metallic mercury, which is also liquid at room temperatures. Like water, but unlike most elements, the density of gallium is greater as a liquid than as a solid; gallium actually expands on solidifying. Gallium wets many types of nonmetallic surfaces, such as glass and porcelain. As in the case of aluminum, a protective natural oxide film forms readily on the surface. Even when heated to temperatures as high as 1000 F, a globule of gallium will remain bright and shiny. This combination of properties should make possible a variety of unusual applications for gallium.

Traces of gallium are found in a variety of ores and minerals, but it is being derived by Alcoa from bauxite. It is estimated that the bauxite from which aluminum is extracted contains only about one ounce of gallium per ton. Separation and recovery of such minute quantities is a difficult and expensive task. The low concentration of gallium in ores, and attendant difficulties of production, have been a hindrance to the development of uses for this rare metal.

Chemists of Alcoa's Aluminum Research Laboratories have found a practical way of separating and concentrating the gallium oxide occurring in bauxite. From the oxide, metallic gallium of high purity is being produced. As a result of these accomplishments, the company is now able to offer metallic gallium in limited quantities.

Oyster Harvester

A MODERN method of harvesting oysters, picking them up by suction from the ocean beds where they have been cultivated, through the use of equipment which resembles a giant vacuum cleaner, is reported by H. C. Rowe and Company, New Haven, Conn. The system is said to have many advantages over older methods.

The dredge blade and nozzle, somewhat similar to those of vacuum cleaners, with an opening approximately six feet wide and seven inches high, travels along the ocean floor behind a dolly equipped with a rubber tire. As it is pulled along by the vessel it brings practically everything which comes within range of its suction from the sea bed including oysters, starfish, other fish, and particularly oyster drills (boring snails), one of the greatest pests in oyster life.

FIG. 14 NEW DEVICE, USING SUCTION SYSTEM, TO HARVEST OYSTERS

Attached to the nozzle is a 20-ft length of 10-in. suction hose which gives greatest flexibility to the equipment both in use and when stored. It is coupled to a 40-ft length of 10-in. steel pipe, and another length of suction hose which is attached to the vessel by a long-radius steel elbow.

To create the suction needed, a centrifugal pump delivers 3600 gpm with a total head of 180 ft. The stream is converted into a jet which passes into an eductor and creates a vacuum in the suction line sufficient to lift 2400 gal of oysters and water a minute. The two streams merge in the throat of the eductor and discharge upward through a hood onto a moving wire screen.

Water is returned to the sea over stainless-steel watersheds and the oysters are carried by the wire-mesh conveyer to the loading space. Rate of catch is about 1000 bushels of oysters hourly. The process is reversed to unload the ship, bucket and belt conveyers being used to discharge the oysters onto a dock-conveying system which carries them to the processing plant. Approximately 225,000 bushels have been harvested by a company vessel since operation of the suction system started.

Among the most important benefits derived, according to officials of the company, is that the method allows the oyster drills (boring snails) among the principal enemies of oysters, to be caught. Using the suction system in clearing a 40-acre bed being prepared to receive oyster seed, the vessel caught and destroyed more than 500,000 of these pests. It is believed that use of this equipment can virtually eliminate the boring snail from setting and growing beds, and thus double their yield of marketable oysters.

Other advantages are that the system is completely mechanical; once it starts operating, it runs virtually by itself, and reduces to a minimum the manual effort needed to harvest oysters. In the old system, where steel dredges were dropped over the vessel's sides, hand labor had to be used to pull and dump the dredges on deck, and additional labor was needed to carry them from the deck to storage. Less than half the number of men can harvest the same amount of oysters with the new method than the old, it is stated.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Petroleum Mechanical Engineering

Mining of Colorado Oil Shale, by Tell Ertl, Union Oil Company of California, Rifle, Colo. 1948 ASME Petroleum Division Conference paper No. **48—PET-11** (mimeographed).

During the past 23 years Union Oil scientists and engineers have been studying the problem of producing fuel and other useful products from oil shale. Their research has resulted in developments which indicate that oil shale can be mined and retorted and that shale oil can be treated to produce liquid fuels at costs not far greater than the present price of similar products produced from petroleum.

The commercial phases of oil-shale production, from mining until the product is ready for the customer, now are being thoroughly studied.

The richest oil-shale deposit and probably the one that first will receive commercial attention is found in the Green River formation of Colorado, Utah, and Wyoming.

The deposits are more than 3000 ft thick and are remarkably uniform in lateral extent. They are relatively flat-lying and are not known to be faulted or fractured.

The Piceance Creek Basin of northwestern Colorado contains the greatest thickness and highest grade of oil-shale deposits known in the United States. The mahogany ledge, that group of oil-shale beds which averages more than 25 gal per ton for a thickness of more than 25 ft, lies under 1000 square miles of the Basin and can yield 100,000,000,000 bbl of shale oil.

Oil shale in the Piceance Creek Basin forms the Roan Plateau which rises sharply to altitudes above 9000 or as much as 4000 ft above the Colorado River.

Cores obtained by the Bureau of Mines from the Naval Oil Shale Reserve indicate that the top of the Roan Plateau consists of shales, sandstones, and marlstones up to 1000 ft in thickness containing only thin beds of oil shale. An oil-shale measure 300 ft thick, averaging more than 15 gal per ton, is found below the surface beds. Directly below and contiguous with the 300-ft-thick oil-shale measure is the mahogany ledge, which on the Union Oil property is nearly 100 ft thick and averages more than 30 gal per ton. Additional oil-shale measures, which may average 15 gal per ton, lie under the mahogany ledge for a thickness of 300 ft.

The 700-ft thickness probably can be mined by surface-mining methods after the 300 to 700 ft of overburden are removed. The total cost of removing the overburden and mining the oil shale would be very low, perhaps as low as 30 cents per ton of oil shale mined, or 2 cents per gal of shale oil recovered.

The mahogany ledge must be mined by underground methods since it is covered with 600 to 1000 ft of rock. Underground mining costs are usually higher than surface-mining costs, but because oil shale is a uniform and strong rock that is amenable to mining on a large scale by the use of cost-cutting mechanical equipment, the mahogany ledge may be mined for as little as 50 cents per ton or 1.67 cents per gal.

Experimental mining to date has shown that the oil shale can be mined cheaply by the use of gang drills mounted on trucks or tractors for drilling. The drill holes are charged with dynamite and the charges are detonated. The blasted rock is loaded by electric shovel loaders into large Diesel-driven trucks and hauled to the plant.

The oil shale will be mined and probably crushed underground. The crushed product will be delivered without interruption to a continuous-type retort where it will be retorted and burned. The burned or spent shale will be discharged continuously. The valuable products are noncondensable gas and shale oil, both of which are fluid and can be piped easily from the elevation of the mine to holders, tanks, or pipe lines on the floor of the valley.

Instrumentation of an Oil Refinery, by T. M. Hoffman, Baytown, Texas. 1948 ASME Petroleum Division Conference paper No. **48—PET-12** (mimeographed).

The instruments found in an oil refinery are those used to indicate, record, and control process variables in practically any modern continuous process. The measurement and automatic control of rate-of-flow, temperature, pressure, and liquid level have, in fact, made possible the highly complex processes utilized in petroleum refining and chemical manufacture. Instruments are also employed for measuring specific gravity, pH, viscosity, and for continuously analyzing process streams for certain constituents. The instrumentation of any continuous process serves to make the process operable, reduce the cost of production, reduce the danger of operation, and insure product uniformity.

One of the most common instruments to be found in a refinery is the flowmeter. Flow rates must be known for material balance calculations in individual plants and for accounting purposes in over-all refinery operations. Three kinds of

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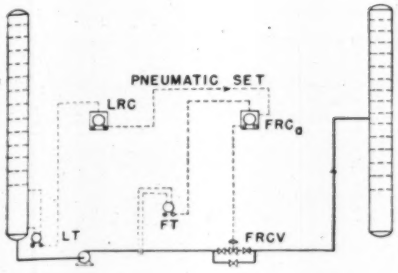


INSTRUMENT COMBINATION SHOWING LIQUID LEVEL CONTROLLER RESETTING A FLOW CONTROLLER

meters are employed in the measurement of flow: the orifice type, the area type, and the volumetric type.

Temperature can be measured by mechanical or electrical means. Examples of the mechanical method of measurement are the ordinary liquid-filled and bimetallic thermometers. The pressure thermometer is another mechanical type which consists of a liquid or vapor-filled sensitive bulb, a length of capillary tubing, and a helix within the instrument case which actuates the indicating, recording, or control mechanism.

The ordinary pressure gage was one of the first instruments ever installed in any process plant, and the number of these gages in any refinery is far greater than all other instruments combined. The most common type is the 4-in. or 6-in-diam gage with an alloy-steel Bourdon-tube movement. Ranges in use run between 30 in. of mercury vacuum and 3000 psi.

Instruments for the measurement of liquid level can be classified into two general groups, namely, those which employ floats and those which operate on the differential-pressure principle. Liquid-level instruments of one sort or another are employed at practically every unit in a refinery.

At times it is advantageous to use a combination of instruments to control some variable in a process. This is generally accomplished by arranging for the output air pressure from one instrument to set the control point of the second instrument which in turn actuates the control valve.

One of the most common instrument combinations is the liquid-level controller resetting a flow controller.

Liquid Fuels From Natural Gas, by R. C. Alden and Alfred Clark, Phillips Petroleum Company, Bartlesville, Okla. 1948 Petroleum Division Conference paper No. **48—PET-13** (mimeographed).

American research and development of the Fischer-Tropsch process has resulted in great improvements which make the gas-synthesis operation appear in a favorable light as an economic source of liquid fuels. The gas-synthesis operation, however, requires very large investments in the order of $3000-$4000 per bbl per day on a battery-limit basis.

According to the paper, the steel requirement of about 6 tons per bbl per day is so great as to take up to 5 per cent of the nation's 1945 steel production for a capacity of 650,000 bpd. A corresponding production of synthetic liquid fuels from coal would take about twice as much investment and nearly twice as much steel. The coal required would equal 28 per cent of the 1945 production thus indicating the concomitant requirement of a considerable expansion of coal-mining facilities. Natural-gas reserves have been increasing at a faster rate than the marketed production of natural gas which has been doubling every eleven years, the paper states. A producible natural-gas reserve of 0.5 trillion cu ft is required to sustain a 7000 bpd gas-synthesis operation for 20 years with a correspondingly greater reserve for longer operations. In only ten states are there known gas reserves of over one trillion cubic feet and only about 50 out of 426 gas-producing fields have gas reserves greater than 0.5 trillion cu ft. It is certain the reserves of the larger gas-producing fields are more heavily committed for established uses. Hence it is pointed out, a substantial gas-synthesis development must depend on new gas discoveries. Even a comparatively small gas-synthesis development will have a profound effect on the markets for the chemical by-products.

It is reported that new gas-synthesis plants will be put in at a slow rate until further process improvements are effected. These may be expected from the two plants now being built and from the numerous research and development programs that are in progress.

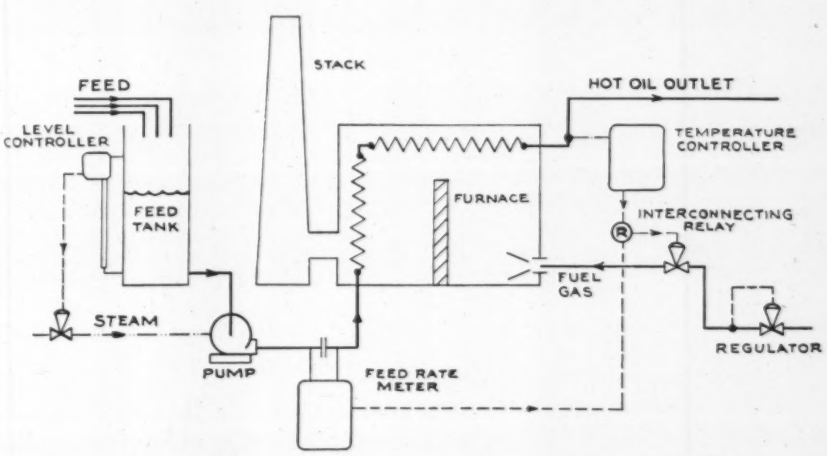
Interconnected Control Instrumentation for Systems Involving Unfavorable Lags, by J. A. Pellettere, Gulf Oil Corporation, Pittsburgh, Pa. 1948 Petroleum Division Conference paper No. **48—PET-14** (mimeographed).

The practice of interconnecting instruments in fluid-flow process control is not entirely new—although most developments along these lines have appeared within the last ten years. It is the purpose of this paper to give in outline form these basic principles, and to explain in some detail a few typical examples, with particular emphasis on systems involving unfavorable lags.

By "interconnecting" is meant, in general, the use of two or more instruments to operate a single control valve; special cases, however, may include three or more interconnected instruments operating two or more control valves.

The paper discusses the following aspects of instrumentation of fluid-flow systems: Reasons for interconnecting instruments; specific examples of systems involving interconnecting; comparison and contrast of such systems to those using three-function simply connected instruments.

According to the paper, interconnected control instrumentation can accomplish the following results, which three-function control instruments alone cannot do: (1) Eliminate or minimize effect of load changes in the controlled fluid stream; (2) maintain stable control conditions in the face of a temporary reversed signal; (3) provide anticipatory action from a secondary high-response instrument.



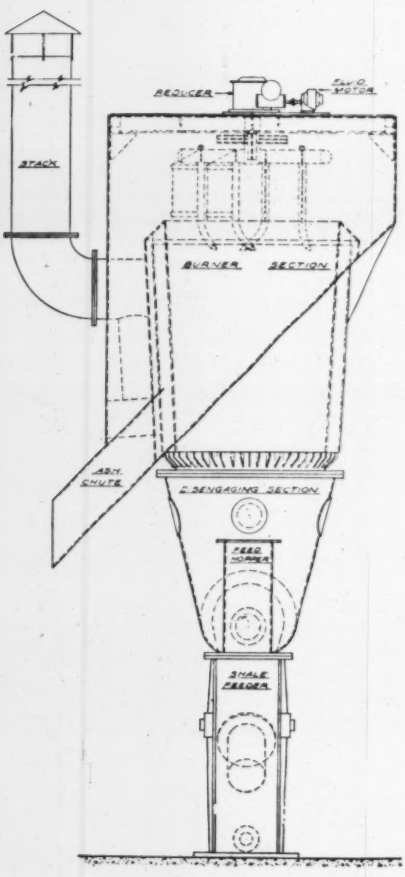
AUTOMATICALLY FIRED TUBE STILL WITH VARYING FEED RATE

Development of Union Oil Retorting Method for the Recovery of Shell Oil, by Homer Reed and Clyde Berg, Union Oil Company of California, Los Angeles, Calif. 1948 Petroleum Division Conference paper No. **48—PET-15** (mimeographed).

The shale-oil reserves of the United States are conservatively estimated to constitute over 1100 billion bbl, of which almost 50 billion are recoverable in Colorado alone.

With the idea of advancing the time when this tremendous energy potential can be utilized, the Union Oil Company is carrying on an extensive program to develop processes for retorting shale and refining the extracted oil.

As the first step in this program, Union has developed a continuous retort which, because of its unique counterflow principle, eliminates the need for large quantities of cooling water and heat exchangers, thereby greatly reducing operating and capital costs. The development studies of this retort have progressed from a 2-ton per day pilot unit to a 50-ton per day semicommercial unit. It is expected that commercial units will reach the capacity of 4000 tons per day of oil shale.



FIFTY-TON PER DAY SEMICOMMERCIAL SHALE KILN

Oil recoveries in the Union shale retorting kiln operation consistently exceed the assay value for the oil content of the shale. Considerable quantities of fuel gas are produced which will provide a large resource of potential power at the retorting and mining site.

Details and operation of the Union Oil retort and descriptions of the 2-ton and 50-ton per day shale kilns are given.

A Case History of Some Pressure Surges, by C. B. Lester, Sohio Pipe Line Company, St. Louis, Mo. 1948 ASME Petroleum Division Conference paper No. **48—PET-16** (mimeographed).

This paper presents some interesting facts regarding pressure surges on a section of a 240-mile 12-in. crude-oil pipe line running between Stoy, Ill., and Lima, Ohio. The main pump stations are largely Diesel-engine-driven centrifugal pump units and the alternate stations or booster stations are largely electric-driven centrifugal pumping units. The entire line operates as a closed system; however, the line is paralleled by a 6-in. pipe line using reciprocating pumps and operating as an open system with tankage at each station. This tankage can be used in an emergency for the 12-in. line and also for purposes of "pressure relief" from the 12-in. line.

This paper is particularly concerned with the first section of the line between Stoy pump station and Coal City, a section about 46.5 miles long. The line is telescoped from 45.55-lb pipe to 39.89-lb pipe, and has a 12-in. loop, a little over three miles long, at the Stoy end. When this line was first built, the Illinois oil fields were approaching their maximum flush production, and the line was so urgently needed that it was placed in service without the customary water test. After operating satisfactorily for a short time, several joints of pipe ruptured at various pressures, and it was then decided that it would be necessary to water-test the entire line. The oil fill was displaced with water, the line tested to 1250 lb, and then placed back in regular operating service. After operating for nearly a year, failures were experienced coincident with electric-power failures at the booster stations, which caused an instantaneous shutdown at these stations. This type of failure caused an immediate increase in the hydraulic gradient over a substantial portion of the line, and pressure surges of the water-hammer variety were naturally suspected. In view of the recurrence of the trouble, it was evident that a study should be made and steps taken to prevent similar failures in the future. This paper is a report and an analysis of the character of long-line pressure surges and the measures taken to alleviate them.

Drilling-Rig Engineering, by William H. Griffith, The International Derrick and Equipment Company, Columbus, Ohio. 1948 ASME Petroleum Division Conference paper No. **48—PET-17** (mimeographed).

This paper discusses certain problems of drilling-rig engineering and illustrates their solution with examples from the design of a 600-hp drilling rig. The specific problems of design discussed are as follows: (1) Transmission—spacing of steps and over-all range; (2) frame—steel plate fully enclosed, welded; (3) brakes—water-cooled brake bands; (4) drum—fabricated in one piece; (5) clutches—design and testing of air-operated friction clutches for operation in the oil spray of the rig transmission; (6) shafts—method of design; (7) chains—selection with regard to load and speed; and (8) bearings—antifriction-bearing selection.

The engineering of oil-field drilling rigs is a branch of heavy-machine design of rather recent development which has not yet matured to the point of having an established literature of its own. It is the purpose of this paper to outline, in a general way, the more obvious characteristics of drilling rigs in the hope that it will be a basis for future discussion and elaboration.

Primary Creep in the Design of Internal-Pressure Vessels, by L. F. Coffin, Jr., Massachusetts Institute of Technology, Cambridge, Mass., and P. R. Shepler and G. S. Cherniak, Lessells and Associates, Boston, Mass. 1948 ASME Petroleum Division Conference paper No. **48—PET-18** (mimeographed).

The paper evaluates the stresses and the permanent strains at a particular time resulting from loading a thick-walled cylinder under constant internal pressure and elevated temperature when account is taken of the primary creep characteristics of a given material. The results are compared with permanent strains obtained by considering secondary creep as the general basis for pressure-vessel design.

For a thick-walled cylinder of wall ratio of $R_1/R_0 = 2.0$, and of 12 per cent chromium steel, operating under 12,000 psi at 850 F, the permanent strain at the end of 25 hr by the primary-creep analysis was found to be equal to the strain at the end of 2000 hr considering only secondary creep.

The methods formulated are shown to

be suitable for design of pressure vessels intended for short life.

A Ring Dynamometer for Pumping Wells, by Douglas O. Johnson, Johnson-Fagg Engineering Company, Tulsa, Okla. 1948 ASME Petroleum Division Conference paper No. **48—PET-19** (mimeographed).

A ring dynamometer for pumping wells which would require a minimum of man power to operate and which would be easy to install so as to eliminate the down time necessary for a test, is described in this paper.

In the design and application of any type of measuring and recording instrument several important factors must be kept in mind. The degree of accuracy desired must be well defined so the most desirable basic machanism may be chosen and this in turn calibrated by a more accurate device. The response of the instrument must cover a sufficient frequency range to faithfully reproduce all of the important variations even though they are of comparatively small magnitude.

When the unit is to be used in the field, portability must be incorporated in the design, and there must be a minimum of adjustments to make, and the accuracy should not be affected by the handling and shipping to which it is subjected.

In order to obtain the truest load characteristic of a pumping well, it is essential that the installation of the instrument can be made without consuming too much down time. This will insure that the load recording is representative of stable pumping conditions.

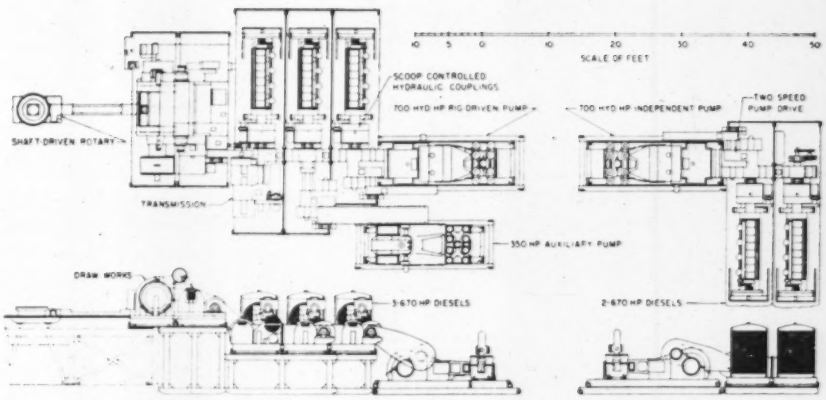
The instrument described in this paper has been developed in order to provide an accurate, rugged, simple device which meets these requirements.

The basic principle selected is to use the deflection of an elastic steel ring as the indicator of load. This deflection is of a sufficient magnitude so as to require a minimum of magnification, and the motivating force present is great enough to allow the use of a rugged mechanical recording mechanism.

The elastic steel ring or proving ring as it is called, is the device developed by the U. S. Bureau of Standards in order to provide a means of calibrating testing machines.

Drilling Rigs for Deep Wells, by Joseph R. Mahan, The National Supply Company, Toledo, Ohio. 1948 ASME Petroleum Division Conference paper No. **48—PET-20** (mimeographed).

Only twenty years ago, in 1928, the record drilling depth was 9000 ft. Ten years later, in 1938, 150 wells had been drilled beyond 10,000 ft and the record stood at 15,002 ft. Now, after another decade, 10,000-ft wells are commonplace, some 400 wells have penetrated beyond 12,000 ft, there are more than 20 below 15,000 ft, and the record stands at 17,823 ft.



LAYOUT OF A 20,000-FT RIG INCORPORATING AN INDEPENDENTLY DRIVEN SLUSH PUMP FOR LARGE CIRCULATION

As the oil industry has been able to resume progress since the end of the war, the subject of even deeper drilling has commanded attention, and a new objective of commercial drilling to 20,000 ft has been expressed.

In accord with general postwar thinking, and in anticipating deeper drilling, operators and manufacturers alike have been exploring the possibilities of improved or even radically different methods of drilling.

Revolutionary departures are difficult to predict in the foreseeable future. It seems more logical to assume that the present technological trend in the drilling industry will result in a continued orderly advance in the art of drilling and in the necessary tools and machinery.

Although a few very large steam rig components have been built in the past, enough other essential elements have been missing to prevent the building, until the present time, of an adequate 20,000-ft drilling rig.

This paper analyzes the loads encountered and the power required in drilling to 20,000 ft by the rotary method. Discussed are the special engineering problems involved in the design of a rig for such depths, with emphasis on internal-combustion-engine power, hydraulic coupling drives, and air controls.

Woodworking Research

The United States Forest Products Laboratory and Industrial Research, by G. M. Hunt, U. S. Forest Products Laboratory, Madison, Wis. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-1** (mimeographed).

The Forest Products Laboratory at Madison, Wis., is an agency of the Forest Service of the U. S. Department of Agriculture. It was established to obtain scientific and technical information on all phases of wood utilization that will provide more satisfactory service from wood, and will make possible more complete and efficient use of the entire wood crop. To carry on this work, the laboratory has a well-trained staff of about 400 people and excellent physical, engineering, chemical, and industrial output.

As a partial means of narrowing the gap between the findings of research and its application to industry, a Forest Utilization Service was been set up at seven of the Forest Experiment Stations throughout the country. These units serve as field representatives of the Forest Products Laboratory to bring its research findings to the attention of local wood users and to encourage their application to local problems.

The Madison laboratory may enter into agreement with Federal or state agencies or with private industry to do research work jointly, on a co-operative basis, in which the co-operator provides funds and the laboratory provides special equipment and research talent. Since the laboratory reserves the right to publish its findings if it appears to be for the public interest, such co-operative studies may not be suitable for industrial problems on the solution of which the co-operator may wish to take out patents or the results of which he may wish to keep secret. These are problems for

private, not government laboratories.

Large companies can afford a relatively large research organization and make it pay. Small companies can get along with less, but no company in the business of making or using wood products should be content to live without some attempt to profit by research.

Research and Educational Facilities in Forest Utilization at the New York State College of Forestry, by N. C. Brown, R. J. Hoyle, and A. H. Bishop, Syracuse University, Syracuse, N. Y. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-2** (mimeographed).

New York is probably the most important wood-using state in the country and uses annually about 3 to $3^1/_2$ billion board-feet of lumber. Since the College of Forestry is a state-supported school, it is only proper that it train men for the wood-using industries, although in 1914 such a program was considered out of place in a forestry school.

Today the forestry faculty of 60 men is divided into eight different departments, one of which is Forest Utilization. There are six men in this department, each of whom is developing a specialty of his own such as wood conditioning; plywood and adhesives, including electronic treatments; marketing of forest products; timber treatments; and other specialized phases of the subject. The department offers some 21 different courses of which the three most important are logging, lumber manufacture, and forest products other than lumber. Other subjects covered are dry-kiln engineering; timber preservation; glues and finishes; woodworking machinery; business methods in the lumber industry; lumber salesmanship; international timber trade; light construction; veneers, adhesives, and plywood.

An important and integral part of the research activities is contact with the 2400 wood-using industries of the state through periodic studies made of the kinds of lumber used by them and the general service to these industries which is known as the Wood Utilization Service. Another important piece of economic research has been the periodic surveys of the wood-using industries, which show among other things that the trend in total consumption of lumber has been downward. However, the curve is now flattening out and may soon be stabilized.

Laboratory facilities for combined research and educational training include a sawmill, a dry kiln, a wood-preservation and treatment laboratory, a woodworking laboratory, and a plywood and electronic laboratory.

Functions of the Independent Research Laboratory, by A. Elmendorf, The Elmendorf Corporation, Chicago, Ill. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-3** (mimeographed).

The forest-products industry is one of the oldest major industries of the country but it was also one of the last to recognize the importance of applied science to its growth. The present impetus for research is a delayed acknowledgment of this fact.

There are several types of laboratories engaged in this research: Government laboratories, such as the U. S. Forest Products Laboratory at Madison, Wis.; laboratories financed with state funds whose work is generally aimed at solving problems unique to the areas served; and the independent laboratories. Independent laboratories are run by the industry association, or maintained individually by the manufacturers themselves for their private use, or exist independently like the Elmendorf Corporation.

Independent laboratories may operate upon either one of two bases, or upon both. Problems may be submitted to them by manufacturers, or by groups of manufacturers. On the first basis of operation, payment is made by the client for the time applied to the project. If any patents are developed, they are assigned to the client. If the problem can be clearly delineated, it is sometimes possible to contract for the investigation as a job, but such instances are rare.

The time has arrived when progressive management no longer looks upon an appropriation for research as a speculation, however hazardous the research work may be. It is being regarded more and more as an insurance against future declines in demand for old products. When viewed in that way, the cost of developmental work should be assessed against the entire production of a company. When so considered, appropriations for research are just as necessary to the life of a business as funds spent for sales promotion and often they are less speculative. In the field of building materials, one per cent of the sales dollar appropriated for research is generally regarded as adequate.

Most large firms that have established research laboratories also employ independent consulting laboratories for part of the work they wish to accomplish. Specialists can be engaged in this manner without incurring the obligation of continuous employment of high-priced personnel. In contrast to the government and state laboratories whose work must be limited to the confines of the laboratory, the independent industrial laboratory can carry a project from the laboratory through the pilot stage into semicommercial manufacture.

Research for the Wood Products Industry, by C. A. Rishell, Timber Engineering Corporation, Washington, D. C. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-4** (mimeographed).

The woodworking industry should undertake product development and research to maintain and expand markets for the product. There is scarcely a wood product for which a substitute material has not been developed.

It is questionable whether a small or even average size manufacturer can afford to conduct fundamental research as contrasted with product development research which is well within the means of even small concerns. Often the inability of firms to make research pay is due to the fact that management relies upon the research laboratory not only to provide technical answers, but also requires that these answers shall be of such nature that no effort or money need be spent in using the knowledge. Once the knowledge is obtained it must be used in production. Funds must be set aside not only for the research but also for the utilization.

Many firms have developed their research organizations through a setup which was intended for quality control. This type of work encourages investigation. Quality control cannot be practiced without thinking up new ideas for improving the product or increasing production.

The principal factors which should be considered in a research contract are as follows: (1) An estimate of cost; (2) what patent rights does the client have under the terms of the contract; (3) what are the publicity features of the contract; (4) the period of the contract; (5) the method of reporting.

The client should require that a maximum limitation be stipulated in regard to cost estimates. The period of the contract may be important in efficiency and cost of conducting research. The research organization can often provide a better and more economical job if it is allowed to choose its own time, and to work small projects in between larger ones which for some reason or other may be at a standstill. The research organization should never be asked to rush a job.

A Small Manufacturer's Privately Owned Laboratory, by C. D. Dosker, Gamble Brothers, Inc., Louisville, Ky. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-5** (mimeographed).

It must be recognized that research is divided into two general classes. The first is basic research, and the second is product research or product development. In viewing research, most small manufacturers do not recognize either the importance or the advantages of a small company-owned laboratory. This is particularly true in the woodworking industry where so little work has been done in the past in the application of new products and new processes to the development and improvements of the products of the individual company.

It is necessary to recognize that research is a tool of management and the laboratory is the actual tool with which the work is done.

The first step is to determine what function the laboratory is to play. It will either be a material-testing laboratory, or a quality-control laboratory, or a laboratory in which the products of the plant are carefully studied in the light of new materials and new processes that might be applied to advantage in developing better consumer appeal.

The research laboratory of a small company should direct its efforts entirely toward the improvement of the company's products. There are many new processes and many new materials that are available to the woodworking industry today, and unless the individual company is willing to take the initiative and attempt to apply these products and materials to the needs of its own production line, they cannot expect someone else to do it for them.

The company should not be too ambitious in the program which it undertakes, and if through its own investigatory work something of promise develops beyond the facilities of its own equipment, it is worth while to consider contractual arrangements with a private laboratory adequately equipped and staffed for the job contemplated.

Two-Species Laminated Beams, by A. G. H. Dietz, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-6** (mimeographed; to be published in Trans. ASME).

Glued laminated beams are customarily made of one species only. Furthermore, it is common practice to make such beams of only one grade of one species, although two grades are sometimes used, and rules respecting the use of two different strength grades in the same laminated beams have been worked out. Consequently, high-strength material sometimes is used on the outer edges of laminated beams and lower-strength material of the same species in the central portion or core.

This paper makes an analysis of the possibilities in two-species beams in which a small amount of heavy strong material is used at the edges with large quantities of lower-grade and different species at the core. Relatively small amounts of high-grade heavy species can be combined with relatively large amounts of the lower-grade lightweight species to yield beams having high strength. Expressions for transformed section, ratio of core depth to over-all depth, and shear at the neutral axis are derived.

Much more testing will be required to establish the validity of this simple theory of two-species wooden beams, but it is believed certain that high efficiency can be obtained with small quantities of low-grade species.

In view of the fact that every possible economy must be achieved if laminated beams, in spite of their many advantages, are to compete successfully with solid beams or with other structural materials, the possibilities in two-species beams should be carefully investigated by engineers. Furthermore, such beams open possibilities in wood utilization with mixed species and mixed grades which may be attractive.

The Fabrication of Structural Members From Timber, by F. P. Forbes, Mem. ASME, Weyerhaeuser Timber Company, Newark, N. J. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-7** (mimeographed).

In the early days, timber was the one readily available structural material that the pioneer used in building. Perhaps the lack of adequate design information was the reason lumber for heavy structures was pushed into the background with the coming of steel and concrete. The use of timber in heavy structures also waned for a period of years because of the weakness of the joints, particularly in tension. The fabrication of timber members required excessive labor and the assembly of the parts was tedious.

HIGHWAY BRIDGE—CENTER SPAN 160 FT, EACH END SPAN 120 FT COMPLETELY FABRICATED AND TREATED

The experimental introduction of timber connectors into this country in the twenties and its subsequent introduction on a commercial basis in 1933, gave impetus to more construction with timber. Clear specimens of timber, not used in timber construction, had been tested and the results of more than 100,000 tests were reported. These tests established a firm foundation for other research. Thus, at the same time that timber connectors were introduced commercially, the American engineer had available the necessary standards, based on authoritative research, to enable him to design in timber with the same feeling of security as with any other structural material.

The assimilation of definite design information in connection with timber structures, the timber connector, the formation of a timber-fabricating industry, and the new attitude toward timber as a structural material as a result of its record in World War II, points toward an increase in the use of timber for structural purposes. As improvements are made in production techniques by the fabricators, there will be a corresponding advance in the art of timber design.

Influence of Depth of Penetration on Withdrawal Resistance of Nails, by E. G. Stern, Mem. ASME, and A. E. Price, Virginia Polytechnic Institute, Blacksburg, Va. 1948 ASME Wood Industries Division Conference paper No. **48—WDI-8** (mimeographed).

The withdrawal resistance or the force required to start the withdrawal of a nail in the direction of its length from a piece of wood is intimately related to the depth of its penetration.

This study on withdrawal resistance was performed in the Virginia Polytechnic Institute Wood Research Laboratory under the auspices of the Virginia Polytechnic Institute Research Foundation, Incorporated.

Data are presented on the withdrawal resistance of 6, 8, 10, and 16-d common wire, nontempered and tempered, Stronghold and Screwtite nails, penetrating for $^1/_3$, $^1/_2$, and $^2/_3$ of the nail shank into the side grain of two 3 × 8-in. seasoned shortleaf pine planks from different trees.

The influences of nail type, size, and depth of shank penetrations on the withdrawal resistance are illustrated. Nontempered and tempered Stronghold and Screwtite nails have a better withdrawal resistance than nontempered nails.

With the exception of tempered Stronghold nails, the withdrawal resistance per inch of penetration of 8, 10, and 16-d nails seems to be higher, in comparison with that for the 6-d nails, than previously anticipated on the basis of direct relationship of withdrawal resistance and nail diameter.

The relationship of withdrawal resistance and depth of shank penetration seems to be curvilinear and not straight line as previously assumed.

Metal Cutting

Progress Report No. 2 on Tool-Chip Interface Temperatures, by K. J. Trigger, Mem. ASME, University of Illinois, Urbana, Ill. 1948 ASME Semi-Annual Meeting paper No. **48—SA-51** (in type; published in Trans. ASME, February, 1949, p. 163).

This report is a continuation of Progress Report No. 1 which was presented in 1947 before the Society. The investigation is principally concerned with the effects of cutting speed upon cutting temperature, chip thickness, and chip hardness, when steel at various hardness levels is machined with cemented-carbide tools. In most of the tests conducted, a steel-cutting grade of carbide tool was used. This type contained tungsten, titanium, and tantalum carbides, and is referred to as a triple-carbide tool. A straight tungsten-carbide tool was used in one series of tests in order to compare the performance with that of the triple-carbide composition. The cobalt content of each grade was normal for the particular type and intended cutting service. Details of the test are given in this paper.

Metals Engineering

How Forging Acts to Enhance Metal Properties, by E. O. Dixon, Mem. ASME, and E. J. Foley, Ladish Company ,Cudahy, Wis. 1948 ASME Semi-Annual Meeting paper No. **48—SA-60** (in type; published in Trans. ASME, February, 1949, p. 147).

Metallurgical literature contains numerous references to the effects of forging upon the physical properties of steel. Heretofore, maximum emphasis has been placed upon development of grain flow with directed methods of hot working. The refinement of crystalline structure from that occurring in the original ingot and the increase in ductility and toughness, particularly in the direction of greatest plastic flow, have been discussed.

It is the purpose of this paper to evaluate the effect of the hot-working method upon the physical properties of steel. The scope of the investigation includes the effect of hammer forging for reductions increasing from zero to 96 per cent, when open dies are used. In order to evaluate more completely the effect of forging upon properties, steel was forged under conditions of restraint employing closed dies. In the closed-die studies, billet material reduced 80 and 92 per cent by rolling was employed. The effect of forging ingot material in closed dies was observed in order to evaluate more completely how the high pressures used in drop-forging influence properties of steel.

Gas Synthesis

Some Problems Associated With the Fischer-Tropsch Process, by Eugene Ayres, C. W. Montgomery, and Joel H. Hirsch, Gulf Research and Development Company, Pittsburgh, Pa. 1948 ASME Petroleum Division Conference paper No. **48—PET-22** (mimeographed).

The Fischer-Tropsch conversion of synthesis gas (carbon monoxide and hydrogen) to motor fuel differs from most production processes in that great volumes of raw product must be handled to make relatively tiny volumes of finished product. About 2000 volumes of synthesis gas plus recycle gas are passed through the reactor to make one volume of liquid motor fuel. The significance of this observation is that while costs must be applied against the one volume coming out, the equipment must be sized to take care of the 2000 volumes going in. Thus the largest part of the cost of the synthesis is on account of the amortization and maintenance of equipment.

With this process characteristic in mind, American chemical engineers have endeavored to push the process toward more economic space-time yields. This has been done by imposing operating conditions much more severe than those used by the Germans. Under typical German conditions care was taken, through the use of relatively low and rigorously controlled temperatures and space velocities, to avoid overloading the catalyst. As a result, the undesirable side reactions which tend to occur on the catalyst under modern synthesis conditions were either nonexistent or of only minor importance. Thus, in improving space-time yields we have greatly aggravated our catalyst problems. In fact, the current tendency is to seek such cheap, naturally occurring, or by-product iron catalysts that catalyst life is not economically controlling. Such an attitude might seem to be justified at the moment by relatively favorable over-all economics, but it amounts to solving the catalyst problems by ignoring them, and such a course may lead to neglect of a broad field of research in which promising advances may be ultimately expected.

This paper discusses briefly a few of the more important catalyst side reactions taking place during the Fischer-Tropsch synthesis, study of which, it is believed, should prove profitable.

ASME Transactions for March, 1949

THE March, 1949, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics*, contains the following:

TECHNICAL PAPERS

Investigation of the Variation of Point Unit Heat-Transfer Coefficients for Laminar Flow Over an Inclined Flat Plate, by R. M. Drake, Jr. (Paper No. 48—A-2)

On the Design of Large Elevator Platforms, by F. Hymans (Paper No. 48—A-10)

A Study of the Supersonic Axial-Flow Compressor, by W. A. Loeb (Paper No. 48—A-5)

Three-Dimensional Solution for the Stress Concentration Around a Circular Hole in a Plate of Arbitrary Thickness, by E. Sternberg and M. A. Sadowsky (Paper No. 48—APM-21)

On the Impact Behavior of a Material With a Yield Point, by M. P. White (Paper No. 48—A-3)

Flow Through a Pipe With a Porous Wall, by F. C. W. Olson (Paper No. 48—A-1)

The Basic Elastic Theory of Vessel Heads Under Internal Pressure, by G. W. Watts and W. R. Burrows (Paper No. 47—A-153)

On the Stability of Plates Reinforced by Ribs, by J. M. Klitchieff (Paper No. 48—A-8)

The Manifold Problem, by J. D. Keller (Paper No. 48—SA-2)

Theory of the Damped Dynamic Vibration Absorber for Inertial Disturbances, by J. E. Brock (Paper No. 48—A-4)

DISCUSSION

On previously published papers by M. C. Shaw and C. D. Strang, Jr.; E. T. Habib; T. K. Wang; S. J. Fraenkel; C. W. MacGregor and R. B. Palme; A. H. Philippidis; and Alice Winzer and G. F. Carrier.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Developments in Burning Pulverized Coal

COMMENT BY A. V. ADAMSON[1]

Supplementing the historical note in Mr. Dornbrook's paper,[2] during the year 1917 the Milwaukee Electric Railway and Light Company entered into an agreement with the Locomotive Pulverized Fuel Company to equip one boiler in the Oneida Street Station with pulverized coal. Contingent upon successful operation, this agreement called for installing pulverized-fuel-burning equipment under the four remaining boilers in this boiler house.

Installation of the equipment was started in December, 1917. Owing to difficulties in shipment and procurement of materials brought about by the first world war, there were some delays in completing the installation, but finally in May, 1918, the first boiler was fired up with pulverized coal. It was immediately apparent that the arch, through which the burners fed the furnace, was set too low; therefore it was taken out and raised as high as possible under the boiler.

During June, a number of tuning-up runs were made, and finally the boiler was ready for a 24-hr acceptance test, which was run August 12 and 13, 1918. This showed an efficiency of 85.22 per cent. It was run under the supervision of the author and approved by Mr. John Anderson. On the day that the test results were completed, the author delegated the writer to notify his company to proceed with the installation of pulverized coal firing under the other four boilers. To the writer the date is very significant in the history of burning pulverized-coal under stationary boilers, because it was the first boiler to be operated successfully with this method of firing not only in a central station but in any industrial plant.

Prior to this time there had been a number of experimental installations which were abandoned, but it was from this date that pulverized coal came into serious consideration and led to development of the large-capacity boilers now common practice throughout the world.

About 1920, Combustion Engineering Company absorbed the Locomotive Pulverized Coal Company and shortly thereafter co-operated with the Bureau of Mines in running a series of additional tests on the original No. 5 boiler at Oneida Street Station. The author refers to the Bureau of Mines' Bulletin No. 223, reporting these tests. This bulletin lists a series of thirty-eight tests, commencing in July, 1920, and continuing through the first week of December, of that year. On the first nine tests during July, the efficiencies ranged from about 76 per cent to 81 per cent, covering the boiler and the superheater. It was during this time that officials of the boiler manufacturer seeing these results, became quite concerned, and the writer was called into a conference in New York and questioned about the low efficiencies as compared to the acceptance test run by the author 2 years previously. The writer was instructed to go to Milwaukee immediately, to fire the boilers under the same conditions as had prevailed during the test and try to raise the efficiencies to a point comparable with the early tests. It will be noted that, starting with test No. 10, the efficiency jumped to 85 per cent, beginning August 9 and continuing through August 19.

On the day of the first test following the writer's arrival, the boiler was made ready and the writer notified Mr. Kreisinger. Then the staff began taking test data. An hour or two later Mr. Kreisinger remarked to us: "The ash is slagging in the bottom of the furnace." We replied: "To get high efficiencies you have to have slag with the furnace limited (as this one was)," because we understood that these tests were being conducted to to prove the efficiency of burning pulverized coal.

This original boiler clearly demonstrated that pulverized coal could be applied successfully to stationary boilers and also indicated certain facts and procedures which had to be followed in subsequent installations, in order to increase availability and reduce maintenance and operating costs. Some of these are as follows:

1 Large furnace volumes are absolutely essential to successful burning of pulverized coal.

2 Long flame and progressive ignition are necessary requisites, in order to keep down furnace turbulence and impingements on furnace refractory walls.

3 Means of cooling refractory walls were found to be essential in order to avoid high furnace maintenance. Air-cooled walls constituted the next step, followed by water-cooled walls, which are in universal use today.

4 It was clearly demonstrated that a wide range of coal could be burned successfully in the boiler, as Indiana, Illinois, West Virginia, and Kentucky coals were all burned at various times in this furnace.

5 It was also evident that improvements must be made in the pulverizing and drying equipment then available, these improvements being required to cut maintenance costs and to reduce power consumption.

6 It was apparent that boilers could be so fired without the arduous labor of using slice bars, and backbreaking work common to other methods of firing in use at that time.

A number of problems developed which, at times, were very discouraging, but the author and his associates never lost faith in the use of pulverized coal. In fact, they were progressive enough to utilize the information and experience gained at Oneida Street to design the first central station at Lakeside to burn pulverized coal exclusively. It was the courage shown by these men that made the rapid development of pulverized coal possible for the use of mankind throughout the world.

COMMENT BY JOHN BLIZARD[3]

The author has given us an interesting review of the development of the art and science of raising steam with pulverized fuel at Milwaukee. He, Mr. John An-

[1] Combustion Engineering-Superheater, Inc., New York, N. Y. Mem. ASME.

[2] "Developments in Burning Pulverized Coal in Milwaukee Plants," by F. L. Dornbrook, MECHANICAL ENGINEERING, December, 1948, p. 967.

[3] Director of Research, Foster Wheeler Corporation, New York, N. Y. Mem. ASME.

derson, and their colleagues were indeed pioneers in this field, and it is important to remember that they initiated their development on a commercial scale, comprising no fewer than five boilers.

Courage and foresight are required for the development of new processes. Once started, no fainthearted direction can be tolerated if the project is to succeed. We may well attribute then the great success of these ventures to the indomitable spirit and skill of the Milwaukee engineers and of the manufacturers of equipment, who overcame the many difficulties related in this paper. Not only were they determined to develop a reliable system but they were aware also of the importance of measuring its efficiency by tests. Of the four authors of the Bureau of Mines publications describing these tests Mr. Henry Kreisinger and Mr. C. E. Augustine are no longer with us. Undoubtedly, the author will feel as the writer does that this is an appropriate time to pay tribute to them. Mr. Kreisinger, the chief planner of the tests, saw very clearly the great future for this method of firing boilers which he strongly advocated.

Seldom has one man worked for so long and contributed so much to an important development of this kind as has the author, and his paper is an important chapter in the history of firing boilers with pulverized coal.

COMMENT BY JOHN VAN BRUNT[4]

This paper is an interesting story of progress in the use of pulverized fuel, and the development of steam-generating units to take full advantage of the possibilities inherent in this method of burning coal.

Much has been done in the past 30 years. Each step forward has been based on experience gained on each installation. The development has moved step by step to the present state of the art, and the Wisconsin Electric Power Company may well take pride in its very considerable share in this revolutionary accomplishment.

It is worth noting that the furnace or combustion efficiency of the Oneida Street installation was equal to that obtained today in the most modern plants.

The writer's interest in the paper is that of one who has been in close contact with each and every step in the development of the installations described.

Many conferences, first with John Anderson, and later with Fred Dornbrook, G. E. Post, M. K. Drewry, Carl John, H. E. Steinhoff, O. J. Stallkamp, H. H. McMillen, and others, were of immense value in impressing on us as manufacturers the viewpoint of the operating engineers.

The meticulous care in details affecting the operating personnel have resulted in well-operated plants requiring a minimum number of station operators.

Preliminary designs were studied and were changed when such changes made for reducing or simplifying the work of the operators and eliminating man power when possible.

There were many arguments as to the best methods to achieve desired results, but, because of the lack of operating background, experience, and data, the conclusions reached were the result of thorough engineering analyses of the many factors of the problems.

Today, operating experience provides the answer to many questions that had no ready answer in the early stages of pulverized-coal firing.

In view of the recent trend to steam reheat, the engineers of the Wisconsin Electric Power Company may take considerable satisfaction in the fact that they were among the pioneers in the adoption of reheat, and unlike many others have continued to use the reheat cycle on all subsequent units except those superimposed on the heating system.

Port Washington is still the world's most efficient station, and if the writer knows the members of the engineering staff of the company (and he most surely does), they will not fall behind in the race for the highest economy of power generation.

COMMENT BY WILLIAM F. RYAN[5]

It will not detract from the value or importance of the work done in Milwaukee to point out that the installation described by the author was not the first important installation of pulverized-fuel firing of power boilers in public-utility plants.

The author states: "At the time of the first world war, in 1917 . . . no one had appreciated the economies and advantages of applying pulverized coal to stationary power boilers." Actually, however, another utility was not merely thinking about the economies and advantages of applying pulverized coal but was burning pulverized coal experimentally, and had a major installation under construction. On April 10, 1917, Puget Sound Traction, Light & Power Company commissioned the writer's company to install a 600-hp boiler in its Western Avenue Station in Seattle, to be fired by pulverized fuel. The contract included the installation of coal- and ash-handling facilities and reconstruction of boiler settings so that the nine existing boilers in the plant could also be fired by pulverized coal. The fuel available was washery sludge from the Renton mine which was just outside the city limits. Experimental work was already under way when the construction job was authorized. The results of this work enabled the engineers to proceed with the designs immediately and the boilers were operated utilizing pulverized fuel early in 1918. The writer is credibly informed that John Anderson[6] visited the Western Avenue Station at about that time and was favorably impressed with the results being obtained.

The author further says: "Such problems as drying and conveying the coal, condensation of moisture in bins, and furnace slagging, had not yet become nightmares to disturb the dreams of the bold pioneers." These problems, however, could not be ignored in the Seattle plant where the washery sludge, up until then regarded as a total waste, averaged 25 per cent moisture, 25 per cent ash (on a dry basis), and had a total heat content of 7300 Btu per lb as fired. Obviously, it was essential that a complete drying plant should be installed and this, together with the other features of the installation, are matters of record.[7] If driers were omitted on the early Milwaukee installations, it is undoubtedly because John Anderson decided that the superior quality of coal available made such refinements unnecessary; the sludge burned at Seattle could hardly have been pulverized with equipment then available, if it had not been predried effectively.

The total rated horsepower of the boiler plant, on the completion of conversion, was 4100 hp, so that the plant was of considerably greater capacity than the original installation at Oneida Street.

The engineering study which led to the recommendation of pulverized fuel at Seattle was authorized by the Power Company in February, 1917. At that time Mr. E. B. Powell, who conducted the fuel-burning studies, found only five pulverized-coal-fired boilers in the United States. These included the following:

Schenectady Works, American Locomotive Company, 275 hp, installed in 1915.

Oliphant Plant, Delaware & Hudson Coal Company (regarded as strictly experimental).

[4] Vice-President, Combustion Engineering-Superheater, Inc., New York, N. Y. Fellow ASME.

[5] Engineering Manager, Stone & Webster Engineering Corporation, Boston, Mass. Fellow ASME.

[6] Chief Engineer, later Vice-President, The Milwaukee Electric Railway and Light Company.

[7] "Washery Sludge Burned in Pulverized Form at Seattle," *Power*, May 4, 1920.

Parsons, Kansas shops, M. K. & T. Railroad, 3000 hp, installed in 1916.

Washoe Smelter, Anaconda Copper Company (supplementary fuel for waste-heat boilers on reverberatory furnaces.).

Western Avenue Station, Puget Sound Traction, Light & Power Company (300 hp, experimental installation, using coal purchased in pulverized form from a briquette manufacturer).

Of these five, only the last was in a public-utility plant, and none was highly regarded as a commercial installation by Mr. Powell, although all of the owners, except Delaware & Hudson, expressed considerable satisfaction with the results.

In regard to the experimental furnace at Western Avenue Station, Mr. Powell reported that the efficiency was low, and the capacity was limited by severe slagging and refractory erosion. However, trial runs indicated remedies for these difficulties, and, with the collaboration of Mr. W. J. Santmyer of the power company, the writer's company proceeded to design and build a highly successful installation, although only the new 600-hp boiler could be set properly for the most favorable furnace conditions.

AUTHOR'S CLOSURE

Mr. Adamson is thanked for his elaboration on the early phase of the pulverized-coal development in Milwaukee. A report on work extending over 30 years did not permit the author to give the detailed account which Mr. Adamson has so generously supplied.

Mr. Blizard pays tribute to Mr. H. Kreisinger and Mr. C. E. Augustine and the author adds the thought that the many power plants throughout the world which burn pulverized coal stand as living monuments to men like them.

Mr. Van Brunt pays compliments which are appreciated and challenging.

The comments by Mr. W. F. Ryan on the contemporary developments in Seattle are most interesting and the author is glad to learn about a fellow pioneer in the development of burning pulverized fuel.

F. L. DORNBROOK.[8]

[8] General Consultant, Power Plant Department, Wisconsin Electric Power Company, Milwaukee, Wis. Mem. ASME.

A Correlation of Viscosity, Temperature, and Pressure

TO THE EDITOR:

Attempts to correlate absolute viscosity, temperature, and pressure quantitatively in a form conveniently applicable to lubricating oils have not been entirely satisfactory. Kinematic viscosity, however, appears to conform to a simple relationship contributing to a fundamental understanding of viscosity and promising valuable practical applicability.

This relationship is based on the assumption that pressure and temperature have exactly equivalent effects on kinematic viscosity. The validity of this assumption is supported quantitatively by data showing the effect of pressure[9] on the viscosity of 1-phenyl-3(2-phenylethyl)hendecane, 1-cyclohexyl-3(2-cyclohexylethyl)hendecane, 9-n-octylheptadecane, and 1-cyclopentyl-4(3-cyclopentylpropyl)dodecane, which vary from 8.9 to 33.6 centistokes at 100 F. In Table 1, pressures at 100 F are listed, together with the mean temperatures at 1 atm which are equivalent to these pressures in their effect on the kinematic viscosity. The observed equivalent temperatures for the four individual hydrocarbons, read from the ASTM D341-39 Viscosity-Temperature chart, only deviate an average of 0.6 deg F from the mean values tabulated, with the maximum deviation being 1.5 deg F.

[9] M. S. Thesis, by E. M. Griest, Pennsylvania State College, September, 1948.

TABLE 1 PRESSURES AND TEMPERATURES

P, psi	t, deg F	P, psi	t, deg F
5000	77.7	30000	9.2
10000	59.5	35000	0.1
15000	43.7	40000	−7.4
20000	30.7	45000	−14.1
25000	18.8	50000	−20.3

These data[10] indicate that a pressure scale can be superimposed upon part of the present temperature scale of the ASTM chart, and the kinematic viscosity produced by any given pressure at a constant temperature can be estimated from the chart simply by extending the straight line connecting any two viscosity-temperature points until it intersects the given pressure line.

Testing the applicability of this method to lubricating oils has been handicapped by the scarcity of sufficiently complete and accurate data in the literature. However, available data indicate that the method is at least approximately correct. For example, three widely different petroleum oils[11] have kinematic viscosities at 5000 psi, 100 F, corresponding to 76.3, 78.3, and 75.3 F at 1 atm, to be compared to 77.7 F in Table 1.

Pressure effects at temperatures other than 100 F could be estimated similarly, using different superimposed pressure scales. For example, published data for a number of very different petroleum oils indicate that at 210 F, the pressure required to produce the same kinematic viscosity as produced by cooling to 100 F at 1 atm is approximately 22,000 psi.

To the extent that this indicated pressure-temperature equivalence is correct, the general observation that oils having low viscosity-temperature coefficients also have low viscosity-pressure coefficients is quantitatively confirmed, and a close similarity of the effects of molecular structure is to be expected.

It is hoped that future studies of the effect of pressure on viscosity will include accurately determined density data and kinematic viscosities, so that the proposed correlation method may be evaluated more conclusively.

R. T. SANDERSON.[12]

[10] These data can be represented by the empirical equation

$$\sqrt{P} = 4718.83 - 1701.54 \log T$$

where P is the pressure in lb per sq in. and T is temperature in degrees Rankine (deg F + 459.7).

Correction

TO THE EDITOR:

Due to an unfortunate authors' error, considerable confusion has arisen in the application of the charts in the paper "Generalized Thermodynamics of High Temperature Combustion," published in the Transactions of the ASME, vol. 70, 1948, pp. 667–676. The plots which appear above the figure captions 1 and 2 should be interchanged.

In addition, on p. 676, column one, in the sample calculation, the quantity of water present is 0.451; line 8 from the bottom of column one should refer to Fig. 6; and the numerical expression on the top line of column two should be taken to the one-half power.

H. C. HOTTEL.[13]
G. C. WILLIAMS.[14]
C. N. SATTERFIELD.[15]

[11] "The Viscosity of Russian and Roumanian Lubricating Oils at High Pressure," by R. B. Dow, J. S. McCartney, and C. E. Fink, *Journal of the Institute of Petroleum*, vol. 27, 1941, pp. 301–309.

[12] Associate Professor, Department of Chemistry, University of Florida, Gainesville, Fla.

[13] Professor of Fuel Engineering and Director of Fuels Research Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. Mem. ASME.

[14] Associate Professor of Chemical Engineering, Massachusetts Institute of Technology.

[15] Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Pulverized-Fuel Conference Report

PULVERIZED-FUEL CONFERENCE REPORT. The Institute of Fuel, London, England, 1948. Paper, 5½ × 8½ in., three parts: Papers (1), illus, figs, 768 pp.; Supplementary Volume of Papers (2), illus, figs, pp. 769–912; Reports (3), figs, illus., Author Index, General Index, pp. 913–1084, set 42s (approx. $8.40).

REVIEWED BY CARL E. MILLER[1]

THE report of this conference on pulverized fuel comprises a very thorough review of the state of the art of pulverized-fuel firing in Great Britain. It consists of three volumes including 71 papers and discussions. The papers cover all phases of pulverized-fuel firing including economics, mining and preparation, influence of national policy, pulverization, combustion, and special applications.

The subjects which are probably of most interest in the United States are those concerned with cleaning high-ash coal and disposal of fly ash. These problems, which are presently facing the British, are ones which will be of greater concern to coal users here in the not too distant future. At the present time, about 80 per cent of the pulverized coal used in Great Britain has an ash content of from 14 to 18 per cent and quality is decreasing.

It was generally agreed that plant investment could be reduced through use of better-cleaned coal because smaller boilers and smaller pulverizers would be required. Therefore, the predominant opinion was that the long-range policy should include arrangements for deashing the fuel for pulverizing in order to reduce capital investment as well as the tonnage of coal that must be moved to the plant and the quantity of ash which must be removed. This is in contrast to our general policy here to build plants to burn coal of any quality. The fact that the coal mines are nationalized, and therefore the cost of these cleaning plants would be borne by the government, may have a bearing on the general opinion expressed, inasmuch as it was indicated that cost of cleaning coal is not reflected accurately in the present price structure in Great Britain. This was attributed to the fact that coal prices during the war years were set more or less arbitrarily, rather than actual cost or value.

The problems of eliminating atmospheric pollution and reducing the cost and space requirements of adequate dust-cleaning equipment and disposing of fly ash received well merited attention. The cost of disposing, as fly ash, of 14 to 18 per cent of the tonnage used in a plant is a large item and needs careful investigation and further research. One method of disposal, which seems to offer possibilities, mentioned in the report, is the making of building block at the plant site from the ash collected.

Many of the recent developments in such items as furnace performance, fly ash collection, and dustless handling of coal and ash were not covered in any detail. Up-to-date information of this type is very desirable as it might minimize decisions such as the recently reported one to use oil as fuel at the Bankside Station in central London. Coal-fired equipment would be much lower in operating cost and much less vulnerable to fuel supply in case of an emergency.

In general, it is believed that the major objectives of this conference were attained, namely, to provide an authoritative work on pulverized fuel, to draw attention to the direction in which research was desirable, and to indicate those characteristics of coal which were detrimental to its use in pulverized form. This group of papers and their accompanying discussions presented by highly qualified engineers, principally from Great Britain, will undoubtedly be of great value in future planning. For those interested in a review of British practices and particularly problems encountered when high-ash coals are the only ones available, these volumes are well worth careful study.

[1] Technical Adviser, Battelle Memorial Institute, Columbus, Ohio. Mem. ASME.

Gas Tables

GAS TABLES: Thermodynamic Properties of Air Products of Combustion and Component Gases; Compressible Flow Functions, including those of Ascher H. Shapiro and Gilbert M. Edelman. By Joseph H. Keenan and Joseph Kaye. John Wiley and Sons, Inc., New York, N. Y., 1948. Cloth, 7½ × 10 in., x and 238 pp., $5.

REVIEWED BY ROBERT V. KLEINSCHMIDT[2]

THE authors are to be congratulated on having produced an extremely useful book. The publishers are also to be congratulated for the excellent form and typography of the volume. The basic weakness in our knowledge of thermal properties of gases which limits the book to the low-pressure region is not the fault of the authors and is a condition which it is hoped will be gradually corrected during the next five or ten years. Until this is done, Gas Tables will undoubtedly be the standard reference work for numerical computations involving air and products of combustion.

If one were to be very critical, one might ask why the authors did not include a table with 100 per cent theoretical air, since this combined with the air table could be used to give results for any other proportion of excess air. However, there is no question that the tables given for 200 and 400 per cent theoretical air will cover the most useful range for gas-turbine work which the authors undoubtedly had particularly in mind.

Among the most interesting features of the book are the large number of auxiliary tables including the tables of functions of pressure ratio for various values of n and the rather extensive treatment of cualities involved in shock phenomena and supersonic flow.

Much of the thermodynamic basis for these tables is not familiar, at least to the older school of engineers, but with the aid of the illustrative examples and a study of the section on sources and methods, anyone can become sufficiently familiar with the theory involved to use the tables. One word of caution is perhaps desirable: Anyone intending to use the tables should seek out the discussion of limitations as to the pressure ranges and accuracies involved, since the tables, as presented, give a somewhat false notion of the probable accuracy for all but the very low-pressure region.

[2] Consulting Engineer, Stoneham, Mass. Mem. ASME.

Thus in the field of rockets, for example, and even in some of the high-pressure gas-turbine applications which are of at least theoretical interest today, results calculated from the tables must be considered as very approximate. For the average engineering calculations, however, the tables leave little to be desired in the way of convenience of manipulation and the range of temperatures covered.

This book will be as necessary for the heat-power engineer as the Steam Tables were twenty years ago.

One Engineer's Family

CHEAPER BY THE DOZEN. By Frank B. Gilbreth, Jr., and Ernestine Gilbreth Carey. Illustrated by Donald McKay. Thomas Y. Crowell Co., New York, N. Y., 1948. Cloth, 5¼ × 8 in., 237 pp., $3.

AS A means of promoting public understanding and esteem of the engineering profession, the ECPD Committee on Professional Recognition in its annual report several years ago, asked for a "popular 'best seller' written with insight and understanding" about the life and work of an engineer.

Although the Committee did not specify a humorous work, the book under review is bound to exceed its fondest hopes. The story of how Frank B. Gilbreth raised and managed a family of 12 children has all the elements of popular appeal. Its revelations of what scientific management can do in the home should give courage to harassed fathers and mothers who are finding themselves overwhelmed by the antics of three or four offspring. Even if the Gilbreth experience has no buoyant effect on the size of the average American family, it should spread an understanding of time and motion study, and disqualify forever the management term "therblig" from the lists of words hopelessly beyond the common understanding.

As one of the pioneers of scientific management specializing in time and motion study, Frank Gilbreth was fond of efficiency. To prevent bathroom congestion he taught his family a specific bathing routine which minimized the strokes needed to wash the body, and insisted that all use it. He taught foreign languages by installing phonographs in the bathrooms so that bathing time could be utilized in listening to German and French. He organized family purchasing committees to buy food, clothes, furniture, and athletic equipment. As each year brought the Gilbreths a "new model," each child was made responsible for the one younger. When a situation demanded a family conference, which was quite often, he blew a whistle and set off a minor earthquake as the Gilbreth horde tumbled out of the corners of the 14-room house in Montclair, N. J.

A family of 12 strained the credulity of all who came in contact with it and was the constant source of amusement to Frank Gilbreth. One day an ardent birth-control worker was directed to the Gilbreth home as a likely center for a Montclair birth-control center.

"We'd like you to be the moving spirit behind the center," she told Mrs. Gilbreth. Before giving her an answer, Mrs. Gilbreth called her husband who blew his magic whistle.

Facing the line-up whose family resemblance betrayed the horrible fact, she exclaimed: "God help us all! Shame on you. And within eighteen miles of national birth-control headquarters in New York."

On another occasion Frank Gilbreth became absorbed in refining operating procedures of the medical profession. It would save time and possibly save lives, he reasoned. But patients and doctors did not take easily to the intrusion of his motion-picture camera into the operating room. Then an idea truck home. Most of the children had bad tonsils. Plans were laid for a mass tonsillectomy in one of the rooms of the Gilbreth home. The camera was set up. A half dozen or so repetitive operations were to be recorded for motion-study analysis later.

As the first pair of tonsils came out the camera caught the quiet efficiency of a familiar surgical routine. The next victim was brought in and put asleep. The doctor peered into the throat and stopped. "My God, Gilbreth," he exclaimed, "I told you I didn't want Martha!"

"You haven't got Martha. That's Ernestine," Frank Gilbreth replied.

Then came an argument about whose tonsils were in whose throats, during which it developed that the doctor knew the children by their tonsils, and that the tonsils under the knife were the only ones that did not have to come out. But out they came because it seemed reasonable enough, since the little girl was already knocked out.

To make matters worse, the cameraman became sick from the mess and preferred to keep his head over the wastebasket. But the last straw came weeks later, when Mr. Coggin, the cameraman, admitted that none of the motion pictures came out because an inside lens cap had been overlooked.

Frank Gilbreth, who had needlessly submitted to a tonsillectomy just to show the family how tough he was, on reading the note bellowed: "I'll track him down to the ends of the earth! I'll take a blunt buttonhook and pull his tonsils out by the by-jingoed roots!"

These are but two of more than a score of incidents which make the account of the Gilbreth household as entertaining as a performance under the big top. They reveal the personality of an engineer apart from his work, one that the public can understand and admire. We need more books of this type. A. F. B.

Jet Propulsion—Turbojets

JET PROPULSION—TURBOJETS. By Volney C. Finch. The National Press, Millbrae, Calif., 1948. Cloth 5½ × 8½ in., 200 figs., xv tables, vii and 328 pp., photolithed, $5.50.

REVIEWED BY ALEXANDER KLEMIN[3]

THE book is an elementary but clear and straightforward presentation of the subject. There is no attempt at originality, no expression of personal opinion on the subject, and the major part of the book is taken without much change from appropriate references. But if we accept the fact that the book is a skillful scissors-and-paste job, then we can agree that it will serve a useful purpose. The literature of the subject is enormous. Students, young engineers, and others seeking the fundamentals of the subject find it difficult to get the basic information in easily understandable form. Here, without much trouble, they will find the information they seek in logical order, well presented and illustrated. Perhaps it is this type of secondary book that is more valuable at this moment than a profound thermodynamic study or the design notes of a practicing engineer. The book begins with history and development; goes on to thermodynamic considerations; performance of turbojets; effects of temperature, humidity, icing and dust. Then it deals with the theory and characteristics of centrifugal compressors, axial-flow compressors and the gas turbine. The later chapters cover fuel systems, combustion chamber, lubrication, thrust augmentation and materials. There are some excellent ex-

[3] Aeronautical consultant, Greenwich, Conn. Mem. ASME.

amples in the text, though no problems at the end of each chapter. Curves, formulaes, references will be useful. The book, unless it changes very greatly, will not have a permanent place in schools or universities, nor will it become anything like a classic for the engineer; but at the present moment it has a place between the purely descriptive books in this field and the books which are devoted mainly to the thermodynamic aspects of the subject. Therefore, for the time being, it will be decidedly useful.

Books Received in Library

ASTM MANUAL OF ENGINE TEST METHODS FOR RATING FUELS. 1948. American Society for Testing Materials, Philadelphia, Pa. Cloth, 6 × 9¼ in., 320 pp., illus., diagrams, charts, tables, $8; to ASTM members, $6. This manual presents in their latest approved form the five standard methods for rating motor, aviation, and Diesel-engine fuels. Six detailed supplements are included which contain information on the best practices currently in use for laboratory facilities, installation of the engine test units, provisions for reference materials, and electrical, water, and air services, and the operation and maintance of the units.

ADVANCED DYNAMICS. By S. Timoshenko and D. H. Young. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, 6 × 9¼ in., 400 pp., diagrams, charts, tables, $5.50. This text presents the general principles of dynamics together with their applications in various engineering fields. Five self-contained chapters deal with the dynamics of a particle, of a system of particles, and of systems with constraints, as well as with the theory of small vibrations and the rotation of a rigid body about a fixed point. About 150 problems, most of them supplied with answers, are included for student solution.

APPLIED MATHEMATICS FOR ENGINEERS AND SCIENTISTS. By S. A. Schelkunoff. D. Van Nostrand Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, 6 × 9¼ in., 472 pp., diagrams, charts, tables, $6.50. This book is devoted to those branches of mathematics which are needed in mathematical physics and engineering. It is divided into two parts, one considering general mathematical methods, and the other, special transcendental functions. Such topics are included as power series, vector analysis, differential equations, linear analysis, Bessel functions, and Legendre functions.

BIBLIOGRAPHIC SURVEY OF CORROSION 1945, a Compilation of Corrosion Abstracts. By R. D. Misch, J. T. Weber, and H. J. McDonald. Corrosion Research Laboratory, Illinois Institute of Technology, Chicago, Ill. Published by National Association of Corrosion Engineers, Houston, Texas, 1948. Cloth, 8¼ × 11¼ in., 129 pp., $5. The abstracts included in this survey are divided into two main classes, general material and patents, each classified into nine main groups: types of attack; investigations in corrosion; effects of specific media; effects in specific equipment; resistance of materials; methods of prevention; coatings; removal of corrosion products; general and miscellaneous, including books. References included have been taken from the 1945 issues of the six principal indexing services covering the field. A detailed subject index and an author index are included.

COMBUSTION ENGINES. By A. P. Fraas. McGraw-Hill Book Company, Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, 6 × 9¼ in., 439 pp., illus., diagrams, charts, tables, $5.50. Intended for the use of engineering-college seniors and engineers in industry, this book develops fundamental relationships from elementary theory and then relates them to practical engineering methods. While primarily concerned with piston-type engines, the more important thermal and mechanical problems of gas turbine are also covered. Twenty-five charts and numerous illustrations are included. Results of wartime and postwar research, not previously circulated, are presented.

DESIGN OF INDUSTRIAL EXHAUST SYSTEMS. By J. L. Alden. Second edition. Industrial Press, New York, N. Y., 1948. Cloth, 5½ × 8¾ in., 252 pp., diagrams, charts, tables, $3.50. This book describes how to design, build, or buy an exhaust system that will meet the requirements of law or of industrial hygiene. It includes exhaust ventilation, low-pressure pneumatic conveying, design of hoods and piping, and structural details, as well as the selection of dust separators, centrifugal and axial-flow fans. Two new chapters on hoods for fumes and on axial-flow fans, as well as lesser additions, are included in this new edition.

DEVELOPMENT OF THE METAL CASTINGS INDUSTRY. By B. L. Simpson. American Foundrymen's Association, Chicago, Ill., 1948. Cloth, 7¾ × 10¾ in., 246 pp., illus., diagrams, maps, $7.50. This book is written to give foundries everywhere data upon which to build programs of public interest, informative to both employee and customer. It covers the development of metal practice from prehistoric times to modern foundry mechanization. Many illustrations add to the text. An extensive bibliography is included.

ENGINEERING WITH RUBBER, edited by W. E. Burton. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1949. Cloth, 6 × 9¼ in., 486 pp., illus., diagrams, charts, tables, $6.50. Based on information from technical catalogs and bulletins, this book gives a comprehensive picture of the engineering, design, and maintenance principles which must be considered in using rubber in industry. The physical and chemical properties of various rubber compounds and the typical dimensions and structural details of industrial rubber products are discussed in detail. Many illustrations and tables are included.

ENGINEER'S SKETCH-BOOK OF MECHANICAL MOVEMENTS, DEVICES, APPLIANCES, CONTRIVANCES AND DETAILS. By T. W. Barber. Seventh edition. E. & F. N. Spon, Ltd., London, S.W.1, England, 1948. Cloth, 5¼ × 8½ in., 355 pp., diagrams, tables, 15 s. This book provides, side by side, brief descriptions and sketches of the various devices in use for accomplishing many specific mechanical movements or works. Such devices as accumulators, bearings, cams, doors, gears, handles, jets, levers, pivots, rotary engines, swivels, and tappets are included. In this fifth edition the text and many of the sketches were revised and many additions have been made.

EVALUATION OF RESIDUAL STRESS. By K. Heindlhofer. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, 5¾ × 8¼ in., 196 pp., illus., diagrams, charts, tables, $4. This book is an advanced treatise on the nature, detection, measurement, and analysis of residual stress. Following an exposition of the significance of residual stress in the metal industry, the limitations imposed on stress analysis by anisotropic metals are discussed. The pertinent phases of the theory of elasticity and the critical representation of data are then treated. Two chapters are devoted to the various methods of observation and the necessary instruments and circuits.

FLUID DYNAMICS. By V. L. Streeter. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, 6 × 9¼ in., 263 pp., diagrams, charts, tables, $5. Designed for use in the second course in fluid mechanics for graduate students, this text is concerned with the development of the general fluid equations and their reduction to specific problems. It covers the ideal fluid theory for both two- and three-dimensional flow, as well as the theory of viscous flow. Assuming a knowledge of calculus, advanced mathematics is introduced and developed as it is needed. Emphasis is placed on the solution of problems which aid the student in his understanding of the theoretical material.

HANDBOOK OF REFRIGERATING ENGINEERING. By W. R. Woolrich and L. H. Bartlett. Third edition. D. Van Nostrand Co., Inc., New York, N. Y , London, England, Toronto, Canada, 1948. Cloth, 5 × 7½ in., 730 pp., diagrams, charts, tables, $8.50. Beginning with fundamental units, primary refrigerants, and charts and tables of thermodynamic characteristics, this handbook continues with detailed descriptions of refrigerating equipment and processes. Special adaptations to ice making, quick freezing, freezer storage, air cooling, and marine refrigeration are dealt with separately. Lubrication, instruments and controls, piping details, and safety measures are also discussed. The extent of revision in the present edition is indicated by the more than 300 additional pages.

JIGS AND FIXTURES. By F. H. Colvin and L. L. Hans. Fifth edition. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, 6 × 9¼ in., 410 pp., illus., diagrams, charts, tables, $4.50. This standard guide provides information covering all aspects of the design and use of jigs and fixtures. In this edition much of the material has been rearranged in order to make the information more easily available. There are also such new data as the new standards for drill-jig bushings, on airplane assembly fixtures, on special fixtures for welding for mass production, and on special fixtures for use in railway shops.

KINEMATICS OF MACHINES. By A. F. MacConochie. Pitman Publishing Corporation, New York, N. Y., and London, England, 1948.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H Phelps, Director, Engineering Societies Library, 29 West 39th St, New York 18, N. Y.

Cloth, 6 × 9¼ in., 217 pp., illus., diagrams, $3. Based on a course presented at the University of Virginia, this book is designed to meet the needs of second and third-year students of engineering. A knowledge of elementary mechanics and mathematics is assumed. Following a review of several simple, early machines is a consideration of the elements of mechanism. Geometry, velocity, and acceleration are considered in their relationship to mechanism. The last section deals directly with the kinematics of simple machine elements.

MACHINE DESIGN DRAWING-ROOM PROBLEMS. By C. D. Albert. Fourth edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1948. Cloth, 5¾ × 9¼ in., 519 pp., illus., diagrams, charts, tables, $5. This book is designed to include in a single volume all the information necessary for drawing-room or laboratory courses in machine design. This new edition has 16 comprehensive problems on machine design and ten chapters of reference information. Fifteen of the old chapters have been revised and the chapters on worm gearing and allowable stresses completely rewritten. Three new problems have been added.

MOTION AND TIME STUDY. By R. M. Barnes. Third edition. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1949. Cloth, 6 × 9½ in., 559 pp., illus., diagrams, charts, tables, $5. This standard text presents the basic principles that underlie the successful use of motion and time study, supplementing each with illustrations and practical examples. In this third edition most of the chapters have been revised and new material added. Five new chapters deal with process analysis, gang-process charts, activity charts, and man and machine charts. Action photographs have been included. There is new material on rating operator performance and motion and time-study training programs.

PLASTIC DEFORMATION, Principles and Theories. By L. N. Kachanow and others, edited by H. H. Hausner. Mapleton House, publisher, 5415 Seventeenth Ave., Brooklyn 4, N. Y., 1948. Linen, 5½ × 8¾ in., 192 pp., diagrams, charts, tables, $8. This book contains translations of five papers on general theory by the Russian scientists, N. M. Beliaev, A. A. Ilyushin, and L. N. Kachanow. Also in the volume are two papers describing the research work of W. Mostow and A. N. Gleyzal. Their research is primarily concerned with the deformation of thin circular and rectangular plates. In these last two papers is a brief history of the previous work done in the field.

PRACTICAL ANALYSIS, Graphical and Numerical Methods. By Fr. A. Willers, translated by R. T. Beyer. Dover Publications, New York, N. Y., 1948. Cloth, 6 × 9½ in., 422 pp., diagrams, charts, tables, $6. This comprehensive work presents the numerical and graphical and many of the instrumental methods of analysis which provide solutions useful to the practical scientist. The first chapter deals with the special problems encountered in calculating with approximate numbers. The succeeding chapters cover standard methods of interpolation, methods of numerical differentiation, practical determination of the roots of single algebraic equations and systems of linear equations, empirical formulas, and the graphical and numerical integration of differential equations.

THEORETICAL STRUCTURAL METALLURGY. By A. H. Cottrell. Longmans, Green & Co., New York, N. Y., Edward Arnold & Co., London, England, 1948. Cloth, 5½ × 8¾ in., 256 pp., diagrams, charts, tables, $5.25; 21s. Written for metallurgical students, this book presents the ways in which ideas of atomic mechanics can be applied to problems of metals and alloys. Based on a theoretical outlook, there is no discussion of experimental methods. The treatment is mainly descriptive, and mathematics is confined to an elementary level. A certain amount of introductory material is included, and the selection of topics is centered around the electron theory of metals and the statistical thermodynamics of metals and alloys.

THEORY AND PRACTICE OF HEAT ENGINES. By V. M. Faires. The Macmillan Company, New York, N. Y., 1948. Cloth, 6 × 9½ in., 388 pp., illus., diagrams, charts, tables, $5. Although suitable for a preliminary course to theoretical thermodynamics, this text is designed primarily for students taking a terminal course in heat power. The customary descriptive matter on engines, turbines, compressors, and steam generators is accompanied by an appraisal of the appropriate theoretical developments. Emphasis is placed throughout the book on the application of the law of conservation of energy by the recurrent use of the general energy equation.

TURNING AND BORING PRACTICE. By F. H. Colvin and F. A. Stanley. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1948. Cloth, 6 × 9¼ in., 531 pp., illus., diagrams, charts, tables, $4.75. After presenting the essential principles, this book describes all the more important varieties of machines in this field, and methods of operating them. This edition contains new cutting-tool data from well-known makers and users of high-speed and carbide tools. A new section on precision boring has been added, and the contents rearranged to make the material more accessible.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is submitted to the Board on Codes and Standards, as authorized by the Council of The American Society of Mechanical Engineers, for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 14, 1949, and approved by the Board on Codes and Standards under the date of February 25, 1949.

CASE NO. 1084

(Special Ruling)

Inquiry: May the edges of inner buttstraps in locomotive-type boilers be sealed by fusion welding if the welding is applied by the same method as provided for attaching nonpressure parts under Paragraph P-186(**e**) (3):

Reply: It is the opinion of the Committee that seal welding of edges of inner buttstraps in locomotive type boilers may be used under the following conditions:

(1) The plates do not contain carbon exceeding 0.35 per cent

(2) The weld metal is deposited in a single layer having a throat thickness not to exceed ¼ in.

(3) The weld metal is deposited intermittently in sections not over 3 in. long, with center-to-center distances not less than twice this length, and peened, and the intervening spaces then welded and peened.

CASE NO. 1090

(Special Ruling)

Inquiry: Is it permissible to use cast iron heads complying with ASTM Specification A-278-44T, Classes 50 and 60, with 0.12 per cent maximum sulphur and 0.25 per cent maximum phosphorus as material for parts for bolted connections to welded wrought steel shell heat exchangers handling nonlethal gases and/or liquids at a maximum temperature of 650 F and a maximum pressure of 300 psi gage.

Reply: It is the opinion of the Committee that cast iron which complies with ASTM Specification A-278-44T, Classes 50 and 60, with 0.12 per cent sulphur and 0.25 per cent maximum phosphorus, will be acceptable as material for parts for bolted connection to welded wrought steel shell heat exchangers handling nonlethal gases and/or liquids at a maximum temperature of 650 F and a maximum pressure of 300 psi gage, under Paragraph U-13(**h**) of the Code; providing all castings are given a thermal stress relieving heat-treatment at a minimum temperature of 950 F, but preferably at 1050 F, for a minimum of 1 hr per in. of section.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

President Truman's "Fourth Point"

When President Truman enunciated the "fourth point" of his inaugural address urging on the United States a "bold new program" of making available to needy countries overseas the vast store of American industrial and technical know-how, he gave sanction to one of the major policies of the Engineers Joint Council. American engineers, by supporting participation of their professional societies in the EJC, have already made substantial contributions in this direction.

EJC International Relations

Through its Committee on International Relations the EJC has aided international exchange of engineering information in three ways. When the war ended and war-devastated countries were sorely in need of technical literature which had been destroyed or had not been received because of disrupted communications, EJC organized its book campaign to meet the need. Since the war, American engineers donated over 70,000 volumes of technical literature to devastated libraries and colleges. Overseas engineers visiting this country to survey American industrial techniques come to the EJC for aid in planning itineraries, and for introductions to American engineers in a position to help them. Perhaps of more importance to overseas countries has been the EJC program of encouraging American engineers to go abroad. Because of EJC sponsorship of American participation in foreign conferences and congresses, more American engineers have a better idea of what can be done to help impoverished countries.

It is a satisfaction to American engineers that their efforts in behalf of overseas colleagues, necessarily limited by meager private funds, should now be supplemented by a promise of support from their Government. The President's fourth point is the major topic of discussion among Washington officials. When a program for action crystallizes, the Government will find American engineers eager and waiting to give their support through the machinery of the EJC.

"Bold New Program"

Since the fourth point may have a profound influence on what engineers may be doing in the years to come, it may be well to study the President's statement. He said:

"Fourth, we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas.

"More than half the people of the world are living in conditions approaching misery. Their food is inadequate. They are victims of erosion. Their economic life is primitive and stagnant. Their poverty is a handicap and a threat both to them and to more prosperous areas.

"For the first time in history, humanity possesses the knowledge and the skill to relieve the suffering of these people.

"The United States is pre-eminent among the nations in the development of industrial and scientific techniques. The material resources which we can afford to use for the assistance of other peoples are limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible.

"I believe that we should make available to peace-loving peoples the benefits of our store of technical knowledge in order to help them realize their aspirations for a better life. And, in co-operation with other nations, we should foster capital investment in areas needing development.

"Our aim should be to help the free peoples of the world through their own efforts, to produce more food, more clothing, more methods for housing, and more mechanical power to lighten their burdens.

"We invite other countries to pool their technological resources in this undertaking. Their contributions will be warmly welcomed. This should be a co-operative enterprise in which all nations work together through the United Nations and its specialized agencies wherever practical. It must be a world-wide effort for the achievement of peace, plenty, and freedom.

"With the co-operation of business, private capital, agriculture, and labor in this country, this program can greatly increase the industrial activity in other countries and can raise substantially their standards of living.

"Such new economic developments must be devised and controlled for the benefit of the peoples of the areas in which they are established. Guarantees to the investors must be balanced by guarantees in the interest of the people whose resources and whose labor go into these developments."

EJC Meets Under New Constitution

1949 Officers Elected

Meeting for the first time on Feb. 7, 1949, under the new constitution approved in principle by four of its five constituent societies, the Engineers Joint Council elected officers for 1949, and heard reports from its Committee on Constitution and By-Laws, National Engineers Committee Consultative to Federal Authorities, Panel on Science Legislation, and others.

The following officers were elected: President, R. E. Dougherty, ASCE, vice-president, New York Central System, New York, N. Y.; vice-president, Scott Turner, AIME, consulting engineer, New York, N. Y.; secretary, W. N. Carey, secretary ASCE; and treasurer, E. L. Chandler, assistant secretary ASCE.

Concurrence of the representatives of all constituent societies on a draft of the Constitution as revised at the last meeting of the Council was reported by Malcolm Pirnie, chairman EJC, Committee on Constitution and By-Laws. The way was now clear for official approval of the document and development of appropriate by-laws. Full text of the EJC constitution appears on the next page.

National Engineers Committee

E. G. Bailey, chairman, EJC National Engineers Committee, Consultative to Federal Authorities, reported that a letter had been sent to Paul G. Hoffman, head of the Economic Co-Operation Administration, and to other Washington officials, offering EJC aid in matters wherein the engineering profession has competence.

To facilitate contacts, the Committee formed a "Washington task force" composed of A. C. Fieldner, U. S. Bureau of Mines; S. E. Reimel, ASME staff; and W. E. Wrather, director, U. S. Geological Survey.

Other task groups to be formed by the Committee include: (1) Defense Organization Group, to study legislation affecting organization of the Army and other defense agencies, and to make suitable recommendations; (2) Engineers in Civil Service Group, to study relationship of the professional engineer to the Federal Civil Service; and (3) Research and Development Personnel Group, to aid the Office of Naval Research in conducting a survey of available research and development engineers.

Science Legislation

B. A. Bakhmeteff, chairman, EJC Panel on Science Legislation, reported that Congress has before it a bill to establish a National Science Foundation. The bill is identical to

the one which was killed last year when Congress adjourned. In view of its probable passage, the Committee will review the list of proposed names of engineers suggested to the President by the EJC for appointment as members of the National Science Foundation.

Proposed legislation connected with the reorganization of the Army was discussed by W. N. Carey, secretary ASCE, who reported that the ASCE Board of Direction had decided to make every effort to maintain and improve the professional status of engineers in military service, including the Reserve and National Guard. The ASCE recommendation, that the EJC take similar steps, was referred to the EJC National Engineers Committee.

New EJC Constitution

AT ITS meeting on Feb. 25, 1949, the Executive Committee of the Council of The American Society of Mechanical Engineers approved the new revised constitution of the Engineers Joint Council.

According to the new membership provisions, ASME representation on EJC for 1949 will consist of the following: Past-Presidents E. G. Bailey and E. W. O'Brien, with R. M. Gates, past-president and member of the ASME Council, serving as official alternate.

The EJC constitution follows:

Article I—Name and Objectives

1 The name of this organization shall be Engineers Joint Council.

2 The objectives of the Council shall be:

(*a*) To advance the general welfare of mankind through the available resources and creative ability of the engineering profession.

(*b*) To promote co-operation among the various branches of the engineering profession.

(*c*) To develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful through the services of the members of the engineering profession.

3 To achieve these objectives, the Council shall:

(*a*) Act as an advisory and co-ordinating agency to seek and study matters of mutual interest to the constituent societies of Council and to recommend parallel action by them.

(*b*) Represent the constituent societies of the Council in instances in which constituent societies deem such joint representation to be desirable.

(*c*) Administer on behalf of the engineering profession, those activities authorized by a majority of the constituent societies of the Council.

Article II—Membership

1 (*a*) The Council shall comprise the two most recent available past-presidents and the secretaries of the constituent societies of Council. Availability of past-presidents shall be determined by the constituent society that they are to represent. Should any constituent society determine that its past-presidents are not available for assignment to EJC, the governing body of such constituent society shall appoint a representative to serve as a member of EJC.

(*b*) The president of each constituent society shall be ex officio a member of Council and shall be expected to attend all meetings with all privileges except that of voting unless serving as an official alternate.

(*c*) Each constituent society shall appoint an official alternate from the membership of its governing board, who shall act as a member of Council, with full privileges, when any member of Council, representing his constituent society, is absent from Council meetings; when not substituting for an absent member he shall have privileges without vote, and shall be expected to attend all meetings of Council.

(*d*) The representatives and alternates of constituent societies shall serve for the calendar year.

2 The constituent societies of the Council shall be: The American Society of Civil Engineers; American Institute of Mining and Metallurgical Engineers; The American Society of Mechanical Engineers; American Institute of Electrical Engineers; and American Institute of Chemical Engineers.

3 A national engineering society may become a constituent society of the Council upon proof that the qualifications required of its members classify them as constituting a generally recognized branch or group of the engineering profession and upon not less than a two-thirds affirmative vote of such constituent societies of the Council. Any member society of EJC may resign from membership upon a 90-day written notice to the secretary of EJC.

Article III—Officers

The officers of the Council shall be a president, a vice-president, a secretary, and a treasurer.

Officers of the Council and their terms of office shall be determined in the following manner:

(*a*) *President:* The president of the Council shall be the most recent available past-president or official representative of a constituent society of Council. The president of the Council preferably shall be selected from the constituent societies in rotation, and in the order named in Article II, Section 2.

The term of office of president of Council shall be one year, and he shall assume office as of January 1 of each year.

(*b*) *Vice-President:* The vice-president of the Council shall be the most recent available past-president or official representative of the constituent society of the Council that will provide the president of Council in the following year.

The term of office of vice-president shall be one year and he shall assume office as of January 1 of each year.

(*c*) *Secretary:* The secretary of the Council shall be selected and his term of office shall be as provided in the By-Laws.

(*d*) *Treasurer:* The treasurer of the Council shall be selected and his term of office shall be provided in the By-Laws.

Article IV—Finances

1 The Council shall maintain a treasury into which shall be deposited all income received from any and all sources by the Council. Funds of the Council may be derived from any source approved by the Council including financial support by the constituent societies of the Council.

2 Financial support by the constituent societies shall be divided proportionately between said societies on the basis of dues income from members. For the purpose of determining the basis of such proportionate financial support the Council shall use from time to time, the ratio of dues income of constituent societies for their respective fiscal years last ended at the time of such determination.

3 Financial support by the constituent societies shall be for specific purposes or activities recommended by a majority of the Council. Any society not electing to contribute to any specific activity for which a part of such financial support is to be made shall not be required to participate in the cost of such part thereof; and, in such event, the ratio of financial support shall be revised in accordance with the dues income of the constituent societies participating in such specific activity.

Article V—Committees

1 *Executive Committee:* There shall be an Executive Committee consisting of the president of the Council as chairman, and the most recent available past-president of each of the other constituent societies.

The Executive Committee shall be authorized to transact, during interim periods between Council meetings, any business consistent with established policy or procedure of the Council.

2 *Committee on Constitution and By-Laws:* The Council shall appoint a Committee on Constitution and By-Laws which shall study, report, and recommend with respect to revisions and amendments of the Council's Constitution and By-Laws.

3 *Other Committees:* The Council shall authorize and appoint all necessary committees to carry out the objectives of Council, utilizing members of the constituent societies and, in addition thereto, members of other societies or persons who are not engineers.

Article VI—Amendments

This Constitution may be amended by an affirmative vote of the governing boards of not less than two thirds of the constituent societies.

Article VII—Quorum

A majority of the membership of the Council, representing not less than two thirds of the constituent societies, shall constitute a quorum.

Resistance Welding

A TREND in American industry to reduce manufacture costs by use of electric-resistance welding was indicated in a recent survey which showed that 1948 shipments of resistance-welding electrodes was 20 per cent greater than in 1947, and that dollar volume of

unfilled orders for resistance-welding equipment on Dec. 31, 1948, was about five times the prewar backlog.

According to the Resistance Welder Manufacturers Association, the peak has not yet been reached. As keener competition develops and the need for reducing manufacturing costs becomes acute, many industries which have been small users of electric welding are expected to consider seriously the advantages of welding and the adoption of new automatic resistance-welding machinery which requires relatively little effort and skill to operate.

Army Critically in Need of Young Engineers

YOUNG mechanical engineers are critically needed by the U. S. Army to carry out its long-range development program currently under way. Realizing that many graduate engineers and those with advanced degrees do not as a rule include the Armed Forces in their plans for a career, the Army is offering special inducement to qualified men.

Direct appointments in the Regular Army as second or first lieutenants are being given by the Department of the Army to young men who by education and experience possess advanced technological knowledge in 68 fields.

Opportunities for mechanical engineers exist in the U. S. Army Chemical Corps, the Corps of Engineers, the Ordnance Department, Quartermaster Corps, and the Signal Corps, in such job classifications as mechanical engineering, industrial engineering, heat engineering, petroleum engineering, industrial management, aeronautical engineering, automotive engineering, and many others for which a mechanical engineer is qualified.

Applicants must be between 21 and 27 years old, although the maximum age may be increased to 30 years by consideration of war service or service since Dec. 31, 1947, as an officer in any Army component. Other requirements include possession of a master's or doctor's degree from an accredited college or university, or a bachelor's degree with at least three years of practical experience in the field for which applying. Applicants may name a first and a second choice of field.

Individuals now attending colleges and universities may submit their applications 10 months prior to completion of their course and they will be notified of their selection for Regular Army commissions at least three months prior to graduation.

For application papers and other information, write to the Officer's Branch, Adjutant General's Section, First Army Headquarters, Governors Island, N. Y.

National Mineral Resources Discussed at AIME Annual Meeting

THE 77th annual meeting of the American Institute of Mining and Metallurgical Engineers, which was held in San Francisco, Calif., Feb. 13–17, 1949, featured 66 technical sessions during which 300 papers on a wide variety of subjects were presented. High lights follow:

Alan M. Bateman, chairman of the department of geology at Yale University, New Haven, Conn., emphasized that the United States was rapidly becoming a "have-not" nation in the case of many vital minerals. He said: "The future demands upon our diminishing domestic resources means that increasingly the United States will have to become more internationally minded with respect to minerals and to become more cognizant of foreign mineral potentialities. . . .

"The mineral-consuming industry in the future will have to lean more heavily on Government, and Government will have to learn to support industry—the two will have to become better team mates. This points to the necessity of establishing a national mineral policy as a part of our foreign policy to help guide and implement our future mineral welfare, and to help avoid ill-advised hand-to-mouth actions."

Uranium

J. K. Gustafson, manager of raw-material operations, U. S. Atomic Energy Commission, stated in a paper read in his absence by Donald H. McLaughlin, that: "The mining industry now has enough elbow room to deal with uranium properties without being unduly hampered by red tape . . . . . American private industry can and should perform the same kind of functions in this country with respect to uranium that it performs with respect to copper, lead, or gold in so far as exploring, developing, mining, and concentrating of ore is concerned—and for the same profit motive."

Philip L. Merritt, also of the Atomic Energy Commission, declared, "It is our firm conviction that normal competitive operations of the mining industry will prove the most effective way in which to assure constant plentiful supply of uranium, the world's most strategic material."

He explained that new sources of uranium must be found if production is to be maintained over a long period of time. Dr. Merritt enumerated the three great pitchblende deposits of the world as (1) the Belgian Congo, (2) the Great Bear Lake region of Canada, (3) Saxony and Bohemia.

Canadian Oil

H. H. Hewetson, president of Imperial Oil Limited, Canada, reviewed recent petroleum discoveries in his country, and interpreted their economic impact upon the north. Declaring that the development of new oil fields in the Canadian prairie areas is converting Canada into a self-sufficient nation with respect to oil, Mr. Hewetson prophesied that the day may quickly come when Canada becomes an oil exporting country.

James Boyd, director of the U. S. Bureau of Mines, declared in an interview that it is "very possible" commercial use of petroleum products extracted from the oil shales of Colorado, Wyoming, and Utah will be feasible in about five years.

Awards Offered for Welding Papers

SIX PRIZE awards totaling $2250 for the best papers on designing for, application of, and research in resistance welding, submitted to the American Welding Society prior to Aug. 1, 1949, have been announced by the Resistance Welder Manufacturers' Association.

Top prize of $750 will be awarded for the best paper from an industrial source dealing with such topics as redesign of a product for lower-cost manufacture by resistance welding, product improvement through use of resistance welding; resistance-welding research; development of new procedures which broaden the usefulness of resistance welding.

Authors of the second and third best papers in this category will be awarded prizes of $500 and $250, respectively.

The author of the best paper submitted by a university instructor, student, or research fellow will receive a prize award of $300, with a $200 prize for the second best paper, from a university source, which in the opinion of the board of awards represent the greatest "original contributions to the advancement and use of resistance welding."

A new $250 prize for the best paper by an undergraduate student has been added this year for the first time.

Anyone in the United States and Canada is eligible to compete for these prizes, the contest judges for which will be appointed by the American Welding Society. "Industrial sources" include not only manufacturing but also consulting-engineering and laboratory organizations.

Copies of rules governing the awards are available from the Resistance Welder Manufacturers Association, 505 Arch Street, Philadelphia, Pa.

UNESCO Book-Coupon Plan Simplifies Purchase of American Books

IF THE new book-coupon plan recently inaugurated by UNESCO (United Nations Educational, Scientific, and Cultural Organization) on a one-year trial basis, wins support of member nations, members of The American Society of Mechanical Engineers and other individuals residing overseas will be able to purchase ASME publications and other American books and periodicals with their own national currencies.

The UNESCO plan was devised to promote the free flow of scientific literature across national boundaries. Because of the difficult foreign-exchange situation many engineers and institutions have not been able to afford American publications.

Under the UNESCO book-coupon plan, persons in war-devastated countries can use national currencies to buy UNESCO coupons. These can then be sent along with the purchase order for needed books in other countries. The coupons are redeemable by UNESCO in the currency of the publisher's country.

The American Booksellers Association, 31

Madison Avenue, New York, N. Y., has been designated as administrator of the plan in the United States. All overseas orders for American books will be channeled through the Association which will pay publishers in dollars and later present book coupons to UNESCO for reimbursement.

To finance the plan during the first year, UNESCO has made $150,000 available from its reserve funds. This money will be used in two ways: $100,000 to support the book-coupon plan in certain co-operating member countries which have agreed to administer sale of coupons through one of their own agencies; $50,000 to cover free distribution of coupons in such war-devastated countries as Austria, China, Czechoslovakia, Greece, Hungary, Italy, Indonesia, Iran, the Philippines, and Poland. Persons residing in the free-distribution countries may obtain more information about the plan from their national ministries of education.

Coupons have been placed on sale in France, India, and the United Kingdom, where the following agencies have been designated as the national distributing bodies: In France, Direction des Bibliothèques de France, 53 Rue Saint Dominique, Paris; in India, The Ministry of Education, New Delhi; and in the United Kingdom, UNESCO Book Coupons, c/o Tokens Limited, 28, Little Russell Street, London. Other countries who have expressed intention to participate in the plan but who have not yet designated a national distributing agency for the coupons are, China, Czechoslovakia, and Poland.

If response to the plan is sufficiently favorable, it is expected that funds other than those provided by UNESCO will be sought to carry the plan beyond the experimental stage.

Inter-Society Corrosion Committee Organized

FIFTEEN delegates and three observers from technical organizations concerned with corrosion met Oct. 28, 1948, at headquarters of the American Society for Testing Materials, Philadelphia, Pa., to formulate the organization of the Inter-Society Corrosion Committee of The National Association of Corrosion Engineers.

The new committee's objectives were outlined in part during the meeting as follows:

1 To promote co-operation among various technical societies working in the field of corrosion.

2 To prepare and publish periodically a directory of corrosion workers in the United States.

3 To provide liaison among technical committees of NACE and other technical societies.

4 To act in advisory capacity to technical societies interested in corrosion in an effort to promote progress of all and avoid duplication of effort.

5 To recommend in which society a proposed new activity might be carried out best without, however, attempting to define or limit the field of activity of any society.

6 To stimulate the publication of reliable data on corrosion and to provide publicity for conferences in this field.

Scope is Widened

The new group will carry on some activities of the former American Co-Ordinating Committee on Corrosion and the NACE Committee on Relations With Other Technical Societies, both of which it succeeds.

Significant decisions during the organization meeting: (1) Established the principle that no working subcommittees of the new organization be formed to duplicate work of member societies' committees; (2) authorized formation of subcommittees covering items cutting across activities of several members; (3) instructed members to submit reports during January each year on corrosion activities being carried on or contemplated in their respective societies; and (4) asked members to keep the committee posted on proposed meetings of their respective societies at which discussion of corrosion would be on the agenda.

Other decisions reached included provisions that the temporary chairman appoint a nominating committee for the offices of chairman and vice-chairman (secretary of the committee is the executive secretary of NACE, under organization rules adopted), that the form of organization be reviewed after permanent officers are elected, and that the next meeting of the committee be held coincident with the NACE 1949 conference during the week of April 11 in Cincinnati, Ohio.

Officers Elected

The following officers were selected: H. H. Uhlig, Massachusetts Institute of Technology, Cambridge, Mass., chairman; Sam Tour, Sam Tour and Company, Inc., New York, N. Y., vice-chairman; A. B. Campbell, executive secretary NACE, secretary ex officio.

S. Logan Kerr, Mem. ASME, consulting engineer, Philadelphia, Pa., represented the ASME at the meeting.

American Engineers Contribute Papers to Second International Technical Congress in Cairo

AMERICAN contributions to the Second International Technical Congress held in Cairo, Egypt, March 20–26, 1949, sponsored by the Engineers Joint Council, consisted of papers on engineering education, river valley developments, and technical literature.

American authors were: W. H. Carson, Mem. ASME, dean, school of engineering, University of Oklahoma, official delegate representing the EJC; Morris L. Cooke, Fellow ASME, Philadelphia management engineer and government consultant; and James S. Thompson, Assoc. ASME, vice-chairman of the board, McGraw-Hill Book Company, Inc., New York, N. Y. Mr. Cooke and Mr. Thompson did not attend the congress.

The World Engineering Conference held its Second International Technical Congress in Cairo at the invitation of the Egyptian government. The congress was devoted to the "discussion of technical and social problems which are of primary importance to the consolidation of peace."

The Committee on International Relations of the Engineers Joint Council was the medium for organizing American participation in the Second International Technical Congress. This world technical body, with headquarters in Paris, has a practical working contact with the United Nations Educational, Scientific and Cultural Organization. Plans for the World Engineering Conference were formulated during the International Technical Congress held in Paris, September, 1946.

Raw Materials Is Theme

Theme of the congress was "Raw Materials as an Industrial and Social Problem," and discussion was divided into three sections: industrial raw materials and their rational utilization throughout the world; social aspects of technical development and of raw material problems; and the problem of water in the Middle East.

In the first section, all problems connected with raw materials, such as their geographical distribution, exploitation, circulation and utilization, were examined in their aspect related to industry. Vegetable and animal raw materials, such as wood, cotton, rubber, and wool, were discussed, as well as the mineral raw materials like coal, petroleum, and ores.

The second section was concerned with all problems relating to dissemination and popularization of applied science and the implications of industrialization on human life. The third section, concerning the problem of water in the Middle-East, considered waterways, seas, subterranean water, and rain water.

Citizenship Responsibilities

Dean Carson's paper, "Engineering Education and the Engineer," stressed the need for educating engineers to devote more time to active participation in social, civic, and political affairs. He emphasized that even though the engineer becomes a humanitarian through promoting the welfare of the human race, he is still sometimes subjected to criticism for his lack of active interest in what are considered normal citizenship responsibilities. Dean Carson pointed out that since this apparent lack of interest stemmed from the engineer's college educational program, educators are making a careful analysis of the engineering curricula to determine what changes should be made.

River Valley Developments

Mr. Cooke's paper entitled, "Multiple-Purpose River Valley Development," presented high lights of this type of project in various parts of the world including Brazil, China, French West Africa, India, Palestine, Scot-

Meetings of Other Societies

April 11–13
American Society of Lubrication Engineers, 4th annual convention and 2nd all-lubrication exhibit, Hotel Statler, New York, N. Y.

April 11–14
The National Association of Corrosion Engineers, annual conference and exhibition, Netherland Plaza Hotel, Cincinnati, Ohio

April 11–15
American Society for Metals, western metal congress, Hotel Biltmore, Los Angeles, Calif.

April 20–23
American Society of Civil Engineers, spring meeting, Hotel Biltmore, Oklahoma City, Okla.

April 26
National Academy of Sciences, annual meeting, Washington, D. C.

May 2–3
Association of Iron and Steel Engineers, annual spring conference, Hotel Lord Baltimore, Baltimore, Md.

May 5–6
American Society for Quality Control, 3rd annual convention, The Copley Plaza, Boston, Mass.

May 8–12
American Institute of Chemical Engineers, Tulsa (regional) meeting, Tulsa, Okla.

May 9–12
The American Mining Congress, coal-mining convention and exposition, Public Auditorium, Cleveland, Ohio

May 11–13
The Engineering Institute of Canada, annual meeting, Chateau Frontenac, Quebec, Can.

May 12–13
The Society of Naval Architects and Marine Engineers, 1949 spring meeting, Palace Hotel, San Francisco, Calif.

May 19–21
Society for Experimental Stress Analysis, spring meeting, Hotel Statler, Detroit, Mich.

May 25
National Industrial Conference Board, Inc., Waldorf-Astoria Hotel, New York, N. Y.

(For ASME Coming Events see page 365)

land, Mexico, and Puerto Rico. He emphasized that while future valley authorities will be identical only in over-all objective to develop to the full, and in complementary fashion, every resource of the watershed for the benefit of the entire population, there should be no attempt at duplication as under one valley authority, hydroelectric development may be the outstanding achievement; in another, spectacular changes in agricultural methods may result; while elsewhere a diversified industry may more or less completely change the way of community life. Mr. Cooke's paper was published in full in the February issue of MECHANICAL ENGINEERING, pages 129–132.

Technical Literature

The responsibility of technical literature as an international influence was the subject of Mr. Thompson's paper. He pointed out that the universal trend towards industrialization, development of new applications in science and engineering, and the necessity for technical knowledge supplied by adequately trained personnel, have created an enormous upsurge in the focusing of international attention upon technology and technical literature.

In Mr. Thompson's opinion, it was the responsibility not only of publishers alone, but also of governments, international organizations, and individuals, to break down the legal, financial, and other obstacles which stand in the way of the freest of cultural interchange between nations. He predicted that removal of these obstacles would result in an increase in world productivity and a rise in living standards for all peoples of the world.

Boiler Feedwater Research Committee Reports 1948 Activities

IN A report of activities for 1948 of the Joint Research Committee on Boiler Feedwater Studies, W. C. Schroeder, Mem. ASME, chairman, lists four programs sponsored by the Committee at meetings of sponsoring organizations, and reports completion of a general reorganization of subcommittees. Dr. Schroeder is chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.

During the year the Engineering Experimental Station operating under the Bureau of Ships, Department of the Navy, resumed participation in the work of the Committee and appointed R. C. Adams as its representative on the Executive Committee. The only other change was the resignation of E. H. Tenney and the appointment of S. F. Whirl as representative of the Edison Electric Institute.

The Committee's first project was joint sponsorship with the American Railway Engineering Association of a program dealing with water treating problems of particular importance in locomotive operation, presented at the annual meeting of the American Water Works Association in Atlantic City, N. J. In June a program on corrosion problems in boiler operations was co-sponsored by the Committee at the annual meeting of the American Society for Testing Materials. During the same month the Committee co-operated with the ASME Power Division in sponsoring a symposium on turbine-blade deposits and steam contamination at the ASME Semi-Annual Meeting, Milwaukee, Wis. In December the Committee again working with the ASME Power Division, presented a program at the ASME Annual Meeting relating to corrosion problems in high-pressure boilers in which particular attention was devoted to the phenomenon of hydrogen embrittlement.

Reorganization of the subcommittees of the Joint Research Committee was also reported by Dr. Schroeder. The following chairmen were appointed: R. C. Bardwell, superintendent of water supply, Chesapeake and Ohio Railway Company, Richmond, Va., Subcommittee on Deposits; E. P. Partridge, director of research, Hall Laboratories, Inc., Pittsburgh, Pa., Subcommittee on Corrosion; and W. L. Webb, American Gas and Electric Service Corporation, New York, N. Y., Subcommittee on Steam Contamination.

The Joint Research Committee on Boiler Feedwater Studies was organized in 1925. Sponsor organizations are: The American Society of Mechanical Engineers, American Boiler Manufacturers Association and Affiliated Industries, American Railway Engineering Association, American Society for Testing Materials, American Water Works Association, and the Edison Electric Institute.

ASHVE Research

AN expanded program of research for 1949 covered by a budget of $225,000 was announced by the American Society of Heating and Ventilating Engineers at its recent annual meeting in Chicago, Ill. Included in the budget is a grant from the U. S. Office of Naval Research for the rapid measurement and recording of heat exchange between the human body and its environment.

As part of the research activities, ASHVE recently formed a ten-man Technical Advisory Committee of the Heat Pump. Headed by R. C Jordan, Mem. ASME, of the mechanical-engineering department, University of Minnesota, Minneapolis, Minn., the group will evaluate and determine satisfactory heat sources for heat-pump applications in temperate zones.

Management Consulting Work

MANAGEMENT engineering is not a field to be entered directly upon completion of an academic curriculum, according to Harold B. Maynard, Mem. ASME, president, Methods Engineering Council, Pittsburgh, Pa. Competence and success in the field come only from hard work. The management consultant must have a thorough grasp of the principles of business organization and a long and varied experience in handling men, materials, machinery, and money before he can hope to apply those principles to the solution of problems confronting the business executive who is working for better results for owners, workers, and the public.

Young men are an asset to a management consulting firm, but they must have the proper background. Mr. Maynard listed the qualifications of young men considered by his firm as:

1 A minimum of five years' practical industrial experience or the equivalent.

2 He should not be younger than thirty and of mature appearance and actions (otherwise he will have difficulty in winning the respect of his client's organization).

3 In connection with his personal characteristics, we stress, in order named: Intelligence, temperament or personality, and previous experience.

Comprehensive Program for Midwest Power Conference

EIGHTEEN members of The American Society of Mechanical Engineers will present papers at the eleventh annual meeting of the Midwest Power Conference to be held at the Sherman Hotel, Chicago, Ill., April 18–19, 1949.

The ASME Chicago Section is sponsoring a luncheon during the first day of the conference which will be followed by a technical session on modern steam generators, sponsored jointly by the Power and Fuels Divisions of the ASME Chicago Section.

The Midwest Power Conference was reorganized in 1938 as a co-operative institution with university and technical-society associations. The major responsibility and sponsorship have been centered in the Illinois Institute of Technology which operates the conference in co-operation with Midwestern universities and sections of national engineering societies.

Technical sessions will be held on the following subjects: Modern steam generators; power-system planning; feedwater treatment; network analyzers; small power plants; control characteristics of industrial processes; central-station equipment; distribution systems; heating and air conditioning; steam contamination; the heat pump; Diesel power; gas turbines; and others.

Papers to be presented by ASME members follow:

Evolution of Today's Central-Station Boiler, by E. M. Powell, Combustion Engineering-Superheater, Inc.

Present Developments in Boiler Design, by Frank X. Gilg, The Babcock and Wilcox Company.

Significance of the Process in Problems of Thermal and Flow Regulation, by Albert F. Sperry, Panellit, Inc.

Removal of Silica From Boiler Feedwater by the Sludge Blanket Hot Process Softener and Exchange Methods, by J. D. Yoder, The Permutit Company.

Evaluation and Location of the Losses in a 60,000-Kw Power Station, by E. F. Obert, Northwestern Technological Institute.

Maintenance of Package Boilers, by F. W. Hainer, Clever-Brooks Company.

Room Air Distribution in Year-Round Air Conditioning, by G. L. Tuve, Case Institute of Technology.

Buyer's Catalog Guide

In this issue beginning on page 41 through to page 66 of the advertising section, are listed 197 items about our advertisers' latest available catalogs, bulletins, and literature covering engineering equipment, materials, and services. Use the coupon on page 42 to make a selection.

Carry-Over Types and the Effect of Design of Drum Intervals Upon Steam Contamination, by P. B. Place, Combustion Engineering-Superheater, Inc.

High-Speed Motion-Picture Study of Steam-Formation Phenomena, by L. O. Gunderson, Dearborn Chemical Company.

Diagnosis of Carry-Over Problems by Proper Plant Test Procedures, by J. A. Holmes, National Aluminate Corporation.

Some Aspects of the Soil Problem in Connection With Heat-Pump Buried-Coil Design, by Donald M. Vestal, Texas A & M Research Foundation.

Controlling the Heat Pump, by F. R. Ellenberger, General Electric Company.

Problems in the Treatment of Cooling Water in Industrial Plants, by L. D. Betz, W. H. & L. D. Betz.

Television, by Fred Compton, The Detroit Edison Company.

Some of the Problems Involved in the Coal-Burning Gas-Turbine Locomotive, by C. K. Steins, Pennsylvania Railroad.

Design of a Locomotive Gas Turbine, by W. B. Tucker, Allis-Chalmers Manufacturing Company.

Water Spray Injection of an Axial-Flow Compressor, by I. T. Wetzel and B. H. Jennings, Northwestern Technological Institute.

Time Study and Methods Conference Planned April 21–22

THE fourth annual Time Study and Methods Conference sponsored by the Society for Advancement of Management and the Management Division of The American Society of Mechanical Engineers, will be held at the Hotel Statler, New York, N. Y., April 21–22, 1949.

The program has been planned to give factual and practical information on time-and-motion-study technique as applied by pioneers in the field to manufacturing, office work, distribution, materials handling, and selling. Speakers will present demonstrations, films, charts, and models, and will allow the audience to handle instruction aids.

Among the topics to be discussed will be: Production short cuts through better layouts; time-study techniques in a small shop; work simplification in multiplant operation; the office as a production unit; a president's view of industrial engineering; new ways of picking industrial-engineering talent; materials-handling studies; controlling indirect labor scientifically; putting new techniques to use; and many others.

Don F. Copell, chief engineer, Wagner Baking Corporation and editor of *Modern Management*, is conference chairman for SAM. David B. Porter, Mem. ASME, professor of industrial engineering, New York University, is conference chairman for ASME.

Registration fees for SAM and ASME members for the full conference including two luncheons and dinner, will be $20; for nonmembers, $25. In the past last-minute registration was so large that many engineers could not be accommodated. To avoid disappointment, early registration is urged. Mail registration checks to the Society for Advancement of Management, Inc., 84 William Street, New York 7, N. Y.

Heat Transfer and Fluid Mechanics Institute

THE California sections of the national engineering societies are co-operating with the California engineering colleges in sponsoring an institute on Heat Transfer and Fluid Mechanics. The institute will be held June 22–24, 1949, on the Berkeley campus of the University of California.

The program has been planned to be of high scientific caliber and will present papers on the basic nature of heat transfer and fluid flow which are representative of the present state of engineering science.

Technical sessions will be held on the general fields of heat transfer and of fluid mechanics, and on energy conversions, combustion, instruments, multiphase flow, and drop dynamics.

Among the sponsoring societies are the West Coast Sections of the American Institute of Chemical Engineers, The American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Institute of Mining and Metallurgical Engineers, American Chemical Society, American Mathematics Society, and the American Physics Society.

The sponsoring universities include Stanford, Southern California, Santa Clara, California at Los Angeles and Berkeley, and the California Institute of Technology.

Accommodations are available in the University of California dormitories. For further information please contact the Department of Institutes, University of California, Berkeley 4, Calif.

U. S. Engineers to Attend Pan-American Congress

IN THE spirit of President Truman's "fourth point" advocating international exchange of American "know-how," more than 40 U. S. engineers have expressed intention to present papers before the first Pan-American Engineering Congress to be held in Rio de Janeiro, Brazil, July 15–24, 1949. Sponsored by the Union of South American Engineers (USAI), the congress is expected to result in the organization of a Union of Pan-American Engineering Societies as a clearinghouse for the common

problems engaging the attention of engineers of the Western Hemisphere.

The idea for the union was first discussed in November, 1947, in Lima, Peru, when James S. Thompson, Assoc. ASME, McGraw-Hill Book Company, Inc., New York, N. Y., representing the Engineers Joint Council, met with representatives of engineering societies of several South American countries. The need for such a union and the advantages of convoking a Pan-American Congress were unanimously recognized, and an organizational meeting to be held in Bogota, Columbia, in October, 1948, was agreed upon. Although the meeting was never held, South American engineers completed a proposed constitution for the proposed union, which has been endorsed in principle by the EJC, and proceeded to organize the Pan-American Congress.

In November, 1948, the Engineers Joint Council and its five constituent societies received invitations from the USAI to participate in the Congress. After endorsing American participation in the Congress, the EJC, through its Committee on International Relations, formed a committee to develop such participation. The committee is composed of the following: S. S. Steinberg, dean, University of Maryland, chairman; Carl Beam, assistant secretary ASCE; C. E. Davies, secretary ASME; Lloyd J. Hughlett, McGraw-Hill International Book Company; E. A. Pratt, consulting engineer; and S. E. Reimel, secretary, EJC Committee on International Relations.

A comprehensive program has been prepared. Under nine committees, the Congress will deal with 29 groups of subjects totaling 211 items of interest to engineers, engineering and technical societies, and to the Governments. International standards in connection with transportation, communications, statistical and technical terms, and many other items; agreements among nations for improvement of lakes and waterways that form their boundaries; the total utilization of river valleys, including use of power development for improving economic and social conditions.

Coming Meetings Notes

Forest Products

THE third annual meeting of the Forest Products Research Society is to be held at the Civic Auditorium in Grand Rapids, Mich., May 2–4, 1949. Six technical sessions have been scheduled. Subjects to be discussed include raw material and its preparation, furniture and plywood, chemical utilization of wood, machining of wood, technical development of research, and seasoning.

Southern Industry

"Meet the Future" will be the theme of the Fourth Southern Machinery and Metals Exposition, which will be held in the Atlanta Municipal Auditorium, in Atlanta, Georgia, April 25–28, 1949.

The latest developments for industry—machinery and tools, products and processes, equipment, tools, and materials-handling devices, will all be included. Many products will be shown for the first time—all designed to give faster, better, and more profitable plant operations.

FRANK T. SISCO, TECHNICAL DIRECTOR OF THE ENGINEERING FOUNDATION

The Southern Industrial Conference on Machinery and Metals, sponsored by the Georgia Institute of Technology, will be held in conjunction with the Exposition, and tours have been scheduled through Atlanta manufacturing plants.

German Industry

Engineers interested in the industrial output of the three Western German Zones, and who may be in New York, N. Y., between April 9 and 24, 1949, will probably not want to miss the Germany 1949 Industrial Show sponsored by 500 firms and 22 industrial groups of Germany, to be held at the Museum of Science and Industry, Rockefeller Center, New York, N. Y.

Principal exhibits will be the following: Electrotechnical products, precision and optical goods, clocks and watches, jewelry, toys, wooden articles, porcelain and glassware, leather goods, textiles, arts-and-crafts articles. Special machinery, tools, and vehicles, will also be represented.

People

A SPECIAL certificate commemorating 65 years of membership in The American Society of Mechanical Engineers, was presented to William F. Durand, past-president and Honorary Member of the Society, at a special gathering of his friends and associates in Palo Alto, Calif., March 1, 1949. Dr. Durand celebrated his ninetieth birthday on March 5.

HONORARY degrees of doctor of engineering were conferred recently on Wat Tyler Cluverius, Mem. ASME, president, Worcester Polytechnic Institute, Worcester, Mass., and on Philip D. Wagoner, Mem. ASME, chairman of the board, Underwood Corporation, New York, N. Y., by the Stevens Institute of Technology, Hoboken, N. J.

FRANK T. SISCO, director, Alloys of Iron Research, has been appointed technical director of the Engineering Foundation, effective March 1, 1949, it was announced recently by J. D. Justin, chairman of the Foundation Board. The Engineering Foundation, joint research agency of American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers, sponsors and supports fundamental research in all fields of engineering.

A native of Kansas, Mr. Sisco was educated at the University of Illinois; he served for ten years in the operating departments of various steel companies, and for seven years as chief of the metallurgical laboratory of the U. S. Army Air Corps at Wright Field, Dayton, Ohio. He has been in charge of Alloys of Iron Research since 1930, and for the present he will continue with this project in addition to his duties as director of the research activities of Engineering Foundation.

J. M. TODD, president ASME, has been named a member of the Committee on Organized Public Support of the President's Highway Safety Conference which is to meet in Washington, D. C., June 1–3, 1949. Frederick J. Graf and E. A. Granniss, Mem. ASME Safety Committee, have been designated alternates. The 1949 meeting of the conference will tackle the problems of traffic safety in small communities and rural areas.

EDWARD H. ROBIE, acting secretary and editor of the American Institute of Mining and Metallurgical Engineers, was confirmed as secretary of the AIME at its annual meeting held recently in San Francisco, Calif.

Education

THE Graduate Fellowship Program established by Shell Union Oil Corporation and its associated companies in the United States, will be continued through the 1949–1950 academic year, the Shell Fellowship Committee announced recently. The program embraces 44 fellowships at 36 colleges and universities in all parts of the country. Of these, 5 will be in mechanical engineering at the following colleges: California Institute of Technology, University of California, Massachusetts Institute of Technology, Northwestern University, and University of Southern California.

Fellowships include tuition and fees of the recipient, a fixed stipend of $1200, and an allotment of $300 to the department of study for equipment or related research expenses.

THE 1949 Summer School for Mechanical Engineering Teachers, sponsored by the Mechanical Engineering Division of the American Society for Engineering Education in cooperation with The American Society of Mechanical Engineers, will be held on the campus of Rensselaer Polytechnic Institute, Troy, N. Y., June 25–July 1, 1949. The summer school will follow the 1949 annual meeting of the ASEE planned for June 20–24, 1949.

Engineering Literature

Proceedings of 1933 Water Hammer Symposium Reissued

TO PLUG the gap in the literature on water hammer caused by the private printing and limited distribution of the Proceedings of the 1933 Symposium on Water Hammer, The American Society of Mechanical Engineers has recently issued a reprint of the 151-page historic document.

In 1931 the ASME Hydraulic Division set out to review existing published literature on water hammer and to sponsor programs to stimulate interest in the subject. Two years later this effort culminated in the Symposium held in Chicago, Ill., with the co-operation of the American Society of Civil Engineers and the American Water Works Association. The eight papers presented immediately found an important place in the literature and had the effect of stimulating research and of correcting the confusion which existed regarding the symbols used in water-hammer studies. As more and more papers on water hammer published in the United States and overseas made reference to the symposium, access to the original Proceedings became essential to a historical understanding for students and workers in the field. In response to many requests for copies of the Proceedings, the ASME authorized reprint of the document. Copies may be obtained from ASME, 29 West 39th Street, New York 18, N. Y. Price per copy is $3.

ASME Standard on Templates and Models Published

A STANDARD covering two-dimensional one-plane templates and three-dimensional equipment models generally used by industry for determining layout of related equipment and structures, has just been published by The American Society of Mechanical Engineers.

The eight-page standard entitled, "ASME Standard for Plant Layout Templates and Models," covers engineering details to be incorporated in design and production of templates and models.

For templates and models, a scale of 1/4 in. equal to one ft is recommended. Different thickness of lines for templates are recommended to show fixed outline of machine tools, detailed parts, overhead and underground elements, and clearances for moving parts. For example, a heavy solid line is recommended to indicate contour of equipment as it would be described on the floor by a plumb line held at a height of seven ft above the floor and moved around the periphery of the equipment touching every extremity. For details such as wheels and handles a thin solid line is indicated.

Printing of templates on different-colored stock is recommended for various classes of equipment: A salmon color for machine tools, green for office equipment, yellow for materials-handling equipment, and red for such space-occupying portable equipment as skids and pallets used for materials handling and temporary storage.

Only details of form, shape, contour, etc., should be incorporated in models to make them readily distinguishable. No dimension should be exaggerated to allow for clearance. Materials recommended are those which will permit a model to be dropped to a solid hard floor from a height of two ft without causing breakage or distortion.

The standard was developed by the ASME Plant Layout Standards Committee under chairmanship of R. W. Mallick, Westinghouse Electric Corporation, Pittsburgh, Pa. Other members of the committee were: A. B. Cummins, Western Reserve University, Cleveland College, Cleveland, Ohio; John Davidson, Western Electric Company, Kearny, N. J.; F. C. Gossett, consultant, Glendale, Calif.; G. E. Hagemann, The Ronald Press Company, New York, N. Y.; H. C. Keller, Lamson Corporation, Syracuse, N. Y.; S. L. Kerr, consultant, Philadelphia, Pa.; L. W. Morse, Monroe Modelers, Monroe, Mich.; and R. Rimbach, Sr., Pittsburgh, Pa.

Standard on Markings for Grinding Wheels Published

PUBLICATION by The American Society of Mechanical Engineers of the American Standard, "Markings for Grinding Wheels and Other Bonded Abrasives ASA B5.17-1949," makes available to industry a standard sequence of six markings which will convey to users such essential characteristics about a particular grinding wheel as, abrasive type, grain size, grade, structure, bond type, and manufacturer's record.

The standard applies to grinding wheels and other bonded abrasives used to alter size or shape or to produce a desired surface or accuracy of dimension, but not to diamond wheels nor to specialities such as sharpening stones, which have their own special markings.

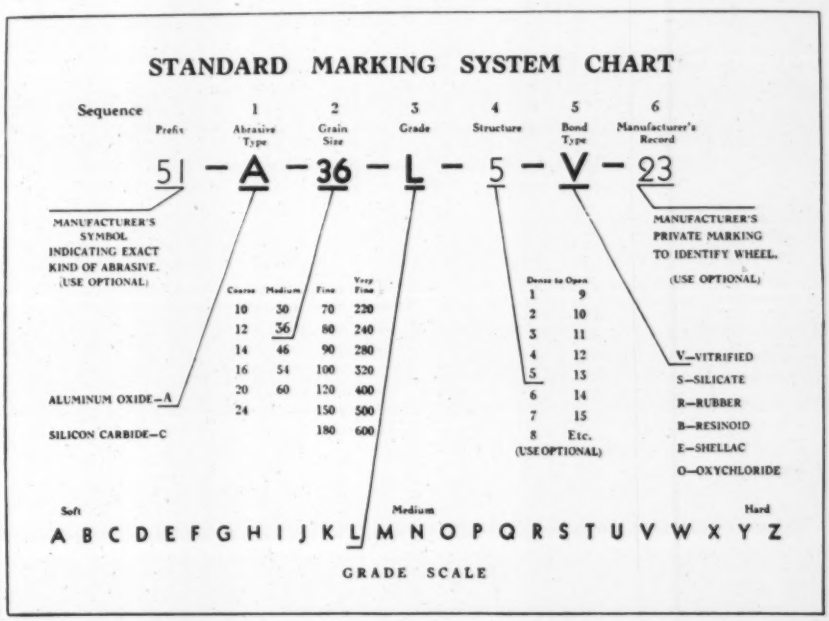
The new standard replaces the 1943 standard which was discontinued in 1946 and was generally not acceptable to industry because of the confusion caused by failure to make clear to users that wheels made by different manufacturers, even though similarly marked, might have different grinding action.

The new document corrects the situation by stating: "This is a standard system of markings only. Wheels bearing the same standard markings if made by different wheel manufacturers may not and probably will not produce the same grinding action. This desirable result cannot be accomplished because of the impossibility of correlating any measurable physical properties of bonded abrasive products in terms of their grinding action."

Other features of the new standard are the adoption of an alphabetical system to designate grade of hardness, and incorporation of provision allowing manufacturers to include whatever special symbols they may require. Copies may be obtained from ASME, 29 West 39th Street, New York 18, N. Y. Price is 30 cents.

* * *

THE Instrument Society of America recently issued two recommended practices, the first, RP1.1 "Coding of Thermocouple Wire and Extension Wire" and the second, RP2.1 "Manometer Tables" which was prepared to encourage standardization of the use of manometers and U-tubes as direct pressure indicating instruments and to aid in the calibration of pressure recorders and controllers.



ASME NEWS

Program for ASME 1949 Spring Meeting New London, Conn., May, 2–4

Headquarters: Mohican Hotel

A FLAVOR of salt and maritime tradition permeates the setting and program of the 1949 Spring Meeting of The American Society of Mechanical Engineers to be held in the old whaling and submarine port of New London, Conn., May 2-4, 1949. Headquarters for the meeting will be the Mohican Hotel. Registration will be free to members and $3 to nonmembers.

For members interested in maritime history, there will be a visit to the old Connecticut port of Mystic with its marine museum housing relics recalling the rugged days of sailing ships. Some idea of the might of the modern American Navy will be caught during a visit to the U. S. Submarine Base, Groton, Conn. Naval policy and world peace will be discussed by Rear Admiral James Fife, commander, submarine force, U. S. Atlantic Fleet, at the banquet on Tuesday. The marine theme will be carried through the technical sessions where a paper on training and indoctrination of submarine personnel will be presented. Three other papers on various phases of marine fouling will be discussed in a session sponsored by the Power Division.

Technical Sessions

Other features of the technical program will be a panel discussion on small-plant management, which will interpret New England experience in this field. Two papers on jet-propulsion and torpedo-propulsion systems will be presented by the American Rocket Society, an ASME affiliate. Irving E. Moultrop, honorary member ASME, will review 50 years' development of steam-power stations. Two papers on health instruments in nuclear-energy application will be sponsored by the ASME Nuclear Energy Committee. On Wednesday morning representatives of industry and education will discuss problems of graduate-engineer training in a session planned as a forum.

In addition to the trips to Mystic and Groton, Conn., a visit is planned to the United States Aircraft Corporation plant in Hartford, Conn., where the Pratt and Whitney Wasp air-cooled radial-aircraft engines and turbojet engines are manufactured. The plant has a floor area of 50 acres in addition to large areas devoted to experimental development work and testing. The Rentschler Airport of 650 acres, with three mile-long runways, lies immediately east of the plant. The tour will include the assembly, test, and inspection of aircraft engines as well as the machining of their component parts.

Visit to Montville Station

On Wednesday morning an inspection is planned to the Montville Station of The Connecticut Light and Power Company at Uncasville, five miles north of New London. The station is an interesting example of the progressive development of a generating plant as required by load growth and assisted by the development of the art of steam generation. The original plant was built in 1918 and enlarged in 1932. Last year the plant was again enlarged when the 1918 equipment was removed, and two 300,000-lb per hr pulverized-coal-fired boilers were installed, together with two turbogenerators of 35,000-kw capacity each. The boilers deliver steam at 850 psi and 950 F. The economy of the latest addition is approximately 11,400 Btu per net kwhr. Increases in steam pressure, temperature, and turbine rpm made it possible to install these larger-capacity generators in the foundation space intended for two 10,000-kw turbines.

Interesting Women's Program

The Connecticut Sections have planned an interesting program for wives and relatives of members attending the meeting. This includes luncheons, card parties, and tours to points of historical interest in and around New London. The complete women's program appears on pages 273 and 274 of the March issue of MECHANICAL ENGINEERING.

All Spring Meeting papers for which preprints are available will be on sale at the headquarters hotel. Members are invited to inspect the exhibit of ASME publications. In accordance with the Society's policy, no preprints will be distributed free at technical sessions. Members are urged to purchase preprints in advance of sessions they plan to attend.

The tentative program follows:

MONDAY, MAY 2

9:30 a.m.

Power (I)

The English Station Extension, by R. L. Anthony, manager, utilities section; John O. Mullen, mechanical engineer, Westcott and Mapes, Inc., New Haven, Conn., Chester A. Molsberry, system-planning engineer; and Edward H. Walton, assistant to president, United Illuminating Company, New Haven, Conn. (Paper No. 49—S-8).

Modern Mercury-Unit Power-Plant Design, by H. N. Hackett, construction-engineering division, General Electric Company, Schenectady, N. Y., and Dwight Douglass, superintendent of power, Hartford Electric Light Company, Hartford, Conn.

9:30 a.m.

Materials Handling—Production Engineering (I)

Machining and Assembly in Materials Handling, by Arthur F. Murray, works manager, Electrolux Corporation, Old Greenwich, Conn.

Materials Handling and How It Applies to Foundry Operations, by R. M. Covert, supervisor of stores and transportation, Westinghouse Electric Corporation, East Springfield, Mass.

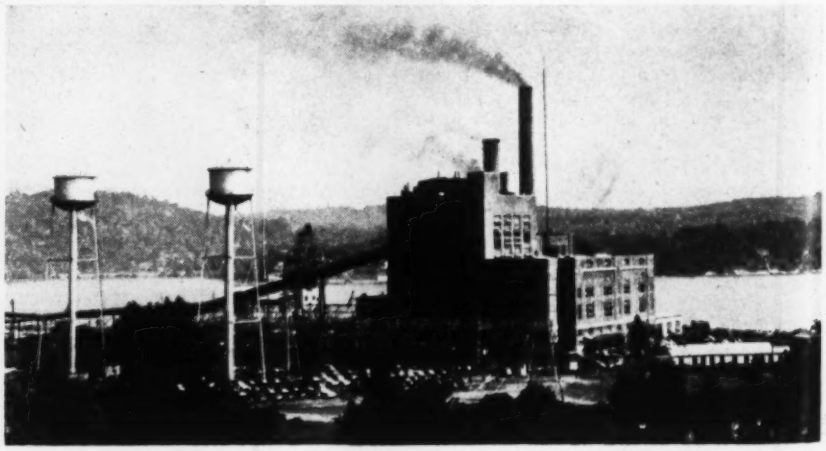
12:00 noon

Welcoming Luncheon

Presiding: S. W. Dudley, dean emeritus, school of engineering, Yale University, New Haven, Conn.

Subject: The Engineer's Part in the Prosperity of Tomorrow.

Speaker: Harry R. Westcott, president, Westcott and Mapes, Inc., New Haven, Conn.



MONTVILLE STATION OF THE CONNECTICUT LIGHT AND POWER COMPANY TO BE VISITED DURING ASME 1949 SPRING MEETING, NEW LONDON, CONN., MAY 2–4

MEMBERS OF THE ASME CONNECTICUT SECTIONS IN CHARGE OF LOCAL ARRANGEMENTS FOR THE ASME SPRING MEETING, NEW LONDON, CONN., MAY 2-4

(*Seated at table:* H. R. Shailer, Jr., member, Entertainment and Banquet Committees; F. M. Gunby, vice-president ASME Region I; L. A. Lachman, general chairman; Robert Wosak, secretary; J. P. Heumann, assistant secretary. *Standing, first row:* R. J. Andrews, Jr., assistant chairman, Finance Committee; J. S. Leonard, chairman, Hotel Committee; F. Horan, member, Hotel Committee; A. C. Crownfield, chairman, Finance Committee; William E. Hogan, chairman, Ladies Program and Information and Registration Committees; and O. B. Schier, 2nd, Meetings Manager, ASME. *Standing, second row:* Ernest Hartford, executive assistant secretary, ASME; Willis F. Thompson, chairman, Publicity Committee; C. H. Coogan, Jr., chairman, Technical Events Committee; T. M. Rianhard, chairman, Entertainment and Banquet Committees; R. L. Weil, chairman, Plant Trips Committee, and I. T. Hook, member, Reception Committee.)

2:00 p.m.

Inspection trip to United Aircraft Corporation, East Hartford, Conn.

2:30 p.m.

Management (I)

Development and Application of Communication Techniques in Labor-Management Relations, by E. S. Grant, vice-president, industrial relations, and A. C. Crownfield, Jr., general superintendent, The Allen Manufacturing Company, Hartford, Conn.

Apprenticeships in Manufacturing Management, by A. V. Feigenbaum, engineer, and H. W. Tullock, manufacturing staff, apparatus department, General Electric Company, Schenectady, N. Y.

The Human Engineering Approach to the Selection of Submarine Personnel, by Capt. T. L. Willmon, Medical Corps, U. S. N., U. S. Naval Medical Research Laboratory, Submarine Base, New London, Conn.

2:30 p.m.

Power (II)

Fundamentals of Marine Fouling, by W. F. Clapp, marine biologist, William F. Clapp Laboratories, Inc., Duxbury, Mass.

Project Study for the Mitigation of Marine Growth, by T. A. Patten, general superintendent, Lynn Gas and Electric Company, Lynn, Mass.

Control of Marine Fouling in Sea-Water Conduits and Cooling-Water Systems Including Exploratory Tests on Killing Shelled Mussels, by Harold E. White, mechanical engineer, Stone and Webster Engineering Corporation, Boston, Mass.

Control of Marine Fouling by Temperature at Redondo Steam Station, by W. L. Chadwick, manager of engineering department, Southern California Edison Company, Los Angeles, Calif., and F. S. Clark, consulting engineer, Stone and Webster Engineering Corporation, Los Angeles, Calif.

2:30 p.m.

Industrial Instruments and Regulators—Heat Transfer (I)

Heat-Conduction Errors in Temperature Measurements, by Lawrence E. Smith, development engineer, The Bristol Company, Waterbury, Conn.

The High-Speed Analog Applied in Industry, by G. A. Philbrick, president, Philbrick Researchers, Inc., Boston, Mass.

8:00 p.m.

Management (II)

Panel Discussion: Small Plant Management

Speakers:

W. C. Beekley, president, The Whitlock Manufacturing Company, Hartford, Conn.

Oliver P. Swope, Jr., department of business and engineering administration, Massachusetts Institute of Technology, Cambridge, Mass.

Myles L. Mace, associate professor, graduate school of business administration, Harvard University, Boston, Mass.

Carl A. Gray, president, Grenby Manufacturing Company, Plainville, Conn.

8:00 p.m.

Production Engineering (II)

Man-Au-Trol Applications to Machine Tools, by L. J. Baudis, chief engineer, The Bullard Company, Bridgeport, Conn.

Materials for Precision Cutting Tools and Gages, by Alexander H. d'Arcambal, vice-president and consulting metallurgist, Pratt and Whitney Division, Niles-Bement-Pond Company, West Hartford, Conn.

8:00 p.m.

American Rocket Society

Underwater Jet-Propulsion Systems, by Calvin A. Gongwer, development engineer, Aerojet Engineering Corporation, Azusa, Calif.

Torpedo-Propulsion Systems, by Frederick A. Maxfield, head physicist, Bureau of Ordnance, U. S. Navy, Washington, D. C.

TUESDAY, MAY 3

9:30 a.m.

Machine Design (I)—Education (I)

Cold-Roll Forming of Sheet and Strip, by Elmer J. Vanderploeg, chief draftsman, The Yoder Company, Cleveland, Ohio. (Paper No. 49—S-3)

Industry's Specifications for Graduate Engineers in the Field of Design, by James B. Hartman, associate professor of mechanical engineering, Lehigh University, Bethlehem, Pa. (Paper No. 49—S-1)

9:30 a.m.

Heat Transfer (II)—Aviation (I)

Experimental Determination of Heat-Transfer Rates for Heat-Absorbing Coils Buried in the Earth, by Charles H. Coogan, Jr., professor and head, mechanical-engineering department, University of Connecticut, Storrs, Conn.

Heating and Ventilating of the Martin 202 Airliner, by Robert L. Berner, design specialist, Glenn L. Martin Company, Baltimore, Md.

9:30 a.m.

Power (III)—Applied Mechanics

Fatigue Tests on Flanged Assemblies, by A. R. C. Markl, chief research engineer, and H. H. George, research engineer, Tube Turns, Inc., Louisville, Ky. (Paper No. 49—S-6)

Submarine Operation and Repair, by Comdr. Donald Bear, U. S. N., engineer and repair officer, U. S. Naval Submarine Base, New London, Conn.

10:00 a.m.

Inspection trip to Mystic Marine Museum

12:00 noon

Luncheon

Presiding: Harry E. Harris, consulting engineer, Bridgeport, Conn.

The Engineer and His Philosophy, by F. Alexander Magoun, president, Human Relations, Inc., Boston, Mass., and R. C. Nyman, Yale University, New Haven, Conn.

12:00 noon

Fuels—Power Division Luncheon

Presiding: Edwin Burnley Powell, consulting engineer, Stone and Webster Engineering Corporation, Boston, Mass.

Fifty Years' Development of Steam Power Stations, by Irving E. Moultrop, consulting engineer, Belmont, Mass.

1:30 p.m.

Inspection trip to U. S. Naval Base, Groton, Conn.

2:30 p.m.

Machine Design (II)

The Use of Electrical Controls for Automatic Functions in Thread-Grinder Design, by E. V. Flanders, chief engineer, Jones and Lamson Company, Springfield, Vt. (Paper No. 49—S-2)

A New Noiseless Method for Packing Granular Materials Into Packaging Containers, by William E. Gross, chief, canister-design section, Army Chemical Corps Technical Command, Army Chemical Center, Md. (Paper No. 49—S-4)

2:30 p.m.

Fuels

Stoker Firing Today and Tomorrow, by J. S. Bennett, vice-president, and F. C. Messaros, chief engineer, American Engineering Company, Philadelphia, Pa.

Furnace Performance With Overfire Jets, by William S. Major, development engineer, Bituminous Coal Research, Inc., Pittsburgh, Pa.

Some Aspects as to the Cause and Prevention of Slag Deposits on the Heating Surfaces in Modern High-Pressure Boilers, by E. F. Walsh, assistant superintendent of power stations, The Narragansett Electric Company, Providence, R. I.

2:30 p.m.

Nuclear Energy

Industrial Health Physics, by J. R. Martin, director, health physics division, Kellex Corporation, New York, N. Y.

The Available Health Instruments in Nuclear-Energy Application, by A. O. Beckman, National Technical Laboratory, Pasadena, Calif.

AERIAL VIEW OF U. S. COAST GUARD TRAINING STATION, NEW LONDON, CONN.

6:30 p.m.

Banquet

Toastmaster: F. M. Gunby, vice-president, ASME Region I, associate, Chas. T. Main, Inc., Boston, Mass.

The Road to Peace, by Rear Admiral James Fife, U. S. N., commander, submarine force, U. S. Atlantic Fleet, U. S. Naval Submarine Base, New London, Conn.

Address, by James M. Todd, president ASME.

WEDNESDAY, MAY 4

9:30 a.m.

Textile

Advances in Carpet Weaving, by H. M. Catlin, manufacturing-engineering manager, Bigelow-Sanford Carpet Company, Inc., Thompsonville, Conn.

Loom Developments, by Francis Donahue, Draper Corporation, Hopedale, Mass.

9:30 a.m.

Gas Turbine Power—Aviation (II)

Introductory Remarks, by J. K. Salisbury, General Electric Company, Schenectady, N. Y.

Interaction of Components of Gas Turbines for Aircraft, by Arthur W. Goldstein, aeronautical-research scientist, Lewis Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio.

The Concept of Hydraulic Efficiency as a Measure of Compressor and Turbine Performance, by Paul R. Trumpler, engineer, and W. E. Trumpler, director, centrifugal-engineering department, Clark Brothers Company, Inc., Olean, N. Y. (Paper No. 49—S-7)

9:30 a.m.

Education (II)

Forum: Undergraduate Training

Education's Trend, by C. V. Newsom, assistant commissioner of higher Education, The State of New York, Albany, N. Y.

The Training Program—Employer's View, by M. M. Boring, staff assistant to vice-president in charge of engineering, General Electric Company, Schenectady, N.Y.

A Related Experience, by S. W. Dudley, dean emeritus, school of engineering, Yale University, New Haven, Conn.

The Smaller Employer's View, by B. P. Graves, director of design, Brown and Sharpe Manufacturing Company, Providence, R. I.

Education and Organization, by R. H. McCarthy, superintendent of manufacturing engineering, Western Electric Company, Inc., Kearny, N. J.

Education and Creative Ability, by E. W. Miller, president, The Fellows Gear Shaper Company, Springfield, Vt.

10:00 a.m.

Inspection trip to Montville Power Station

12:00 noon

Luncheon

Presiding: Oscar F. Willhelm, vice-president, Durham Enders Razor Corporation, Mystic, Conn.

The Problems and Significance of Our Alliance With Socialist Europe, by Frederick S. Blackall, Jr., president and treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I.

2:30 p.m.

Metals Engineering

Nondestructive Testing, Its Place in Industry, by H. H. Lester, physicist, The Watertown Arsenal Laboratory, Watertown, Mass.

Radiographic Tests, by James L. Bly, engineer of tests, Pratt and Whitney Division, United Aircraft Corporation, East Hartford, Conn.

An appraisal of the Technological status of Ultrasonics, by Lewis Gold, assistant professor of physics, Brown University, Providence, R. I.

The Selection of Magnetic and Electrical Nondestructive Tests, by Carlton H. Hastings, physicist, The Watertown Arsenal Laboratory, Watertown, Mass.

2:30 p.m.

Safety

ASME and the President's Highway Safety Conference, by J. J. Bailey, supervisor,

auto division, Eagle-Globe-Royal Indemnity Companies, New York, N. Y.

Integrating Safety Engineering in Engineering-College Curricula, by H. W. Heinrich, assistant superintendent, The Travelers Insurance Company, Hartford, Conn.

Methods Analysis as a Factor in Industrial Accident Prevention, by J. V. Grimaldi, director, industrial division, Association of Casualty and Surety Companies, New York, N. Y.

2:30 p.m.

Process Industries

New Development in Rotary Multiport Valves, by H. L. Tiger, vice-president; N. E. Brice, chief engineer; and W. Horodeck, assistant chief engineer, Liquid Conditioning Corporation, Linden, N. J. (Paper No. 49—S-5)

Low-Temperature Cycles and Refrigerants, by David L. Fiske, consulting engineer, New York, N. Y., and Walter F. Jones, centrifugal specialist, Carrier Corporation, New York, N. Y.

ASME Calendar

of Coming Events

April 25–29
ASME Oil and Gas Power Division Conference and Exhibit, Hotel Sherman, Chicago, Ill.

May 2–4
ASME Spring Meeting, Hotel Mohican, New London, Conn.

June 13–15
ASME Applied Mechanics Division Conference, H. A. Rackham School of Graduate Studies, University of Michigan, Ann Arbor, Mich.
(Final date for submitting papers was Feb. 1, 1949)

June 27–30
ASME Semi-Annual Meeting, University of California Extension Building, San Francisco, Calif.
(Final date for submitting papers was Feb. 1, 1949)

Sept. 12–16
ASME Industrial Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
(Final date for submitting papers—May 1, 1949)

Sept. 27
ASME Wood Industries Division Conference, Jamestown, N. Y.
(Final date for submitting papers—May 1, 1949)

Sept. 28–30
ASME Fall Meeting, Lawrence Hotel, Erie, Pa.
(Final date for submitting papers—May 1, 1949)

Oct. 2–5
ASME Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City, Okla.
(Final date for submitting papers—June 1, 1949)

Oct. 26–27
ASME Fuels Division Conference, French Lick Springs Hotel, French Lick Springs, Ind.
(Final date for submitting papers—June 1, 1949)

Nov. 27–Dec. 2
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(Final date for submitting papers—Aug. 1, 1949)
(For Meetings of Other Societies see page 358)

ASME Tour Party Growing

June 18–July 14

ASME members are daily expressing interest in the 1949 ASME Vacation Tour planned in connection with the ASME Semi-Annual Meeting to be held in San Francisco, Calif., June 27–July 1, 1949.

The tour will include stops at the Grand Canyon National Park, the 200-in. telescope at Mt. Palomar, Los Angeles, the Redwood Forests, Yosemite National Park, Mt. Rainier National Park, Yellowstone National Park, Seattle, and the Shasta Dam.

Arrangements can be made for side trips to Hawaii and Alaska.

Write to the secretary for itinerary.

ASME 1949 Oil and Gas Power Conference

MORE than 300 engineers and executives of the Diesel industry are expected to participate in the 1949 Oil and Gas Power Conference sponsored by the Oil and Gas Power Division in co-operation with the Railroad Division of The American Society of Mechanical Engineers, to be held at the Sherman Hotel, Chicago, Ill., April 25–29, 1949.

In addition to an interesting technical program consisting of three sessions at which eight papers will be presented, the conference will feature an exhibit of Diesel engines, accessories, and instruments, and a special lecture course during which authorities will discuss "Gaseous Fluid Flow in Relation to Diesel and Internal-Combustion Engine Design." Visits will also be made to Diesel locomotive repair shops and plants of Diesel manufacturers.

Members who plan to subscribe to the lecture course are advised to register in advance because the size of the audience must be limited to available facilities. This feature of the conference has been so popular in the past that many engineers could not be accommodated. The lecture fee for members is $12 and for nonmembers $15. Payment should be made in advance to John C. Gibb, Room 1323, Socony-Vacuum Oil Company, Inc., 26 Broadway, New York 4, N. Y.

As the largest railroad center in the nation, Chicago is an appropriate location for a conference at which technical papers relating to Diesel locomotives will be discussed. Diesel locomotive engine-cooling systems, training programs for railroad personnel, Diesel-engine maintenance, and the V-type engine, are among the subjects to be discussed by representatives of Diesel locomotive manufacturers.

The full program of the conference appears on pages 274 and 276 of the March issue of Mechanical Engineering.

To cover costs of the conference, a registration fee of $2.50 for members and $5 for nonmembers will be charged. Members and guests planning to attend only one day of the conference will not be required to pay the full fee. Registration for one day will be $1.25 and $2.50 respectively. Preprints will be distributed free only to those who pay the full registration fee.

Engineering Frontiers to Be Theme of ASME 1949 Semi-Annual Meeting

THE 1949 Semi-Annual Meeting of The American Society of Mechanical Engineers to be held in the University of California Extension Building, San Francisco, Calif., June 27–July 1, 1949, will be set amid the festivities celebrating the historic days of a century ago when discovery of gold in California electrified the East Coast and set in motion the great western trek of 1849 which led directly to the granting of statehood to California in 1850.

In the spirit of the centennial, 19 professional divisions and committees of the ASME are planning technical sessions around the theme, "Engineering Frontiers." A round of social events, sight-seeing tours, and inspection trips to scientific laboratories and industrial plants will complete what promises to be a memorable event.

For members who wish to combine a vacation with the Semi-Annual Meeting, the Society is arranging a tour which will stop at many of the National Parks while en route for San Francisco. More than 90 members have expressed interest in the tour, and a congenial party of members and their wives is being organized. More information on the tour may be obtained by writing to the Secretary.

The following Professional Divisions and Committees are planning technical sessions: American Rocket Society, Applied Mechanics, Aviation, Boiler Feedwater Studies, Engineers Civic Responsibility, Education, Fuels, Gas Turbine Power, Hydraulic, Industrial In-

struments and Regulators, Machine Design, Management, Materials Handling, Metals Engineering, Oil and Gas Power, Petroleum, Power, Process Industries, and Railroad.

Inspection Trips

Among the special events planned for the Semi-Annual Meeting are the following: A boat trip around San Francisco Bay and visit to Hunter's Point Naval Base; visit to the cyclotron at the University of California; United Airlines Maintenance Base; Ames Aeronautical Laboratory, Moffett Field; and Station P of the Pacific Gas and Electric Company. If there is enough interest, additional inspection trips can be arranged to many other points. Members are requested to note preference and mail coupon on this page.

The Committee of the San Francisco Section in charge of local arrangements is composed of the following: R. Lannert Iglehart, general chairman; Walter Kassebohm, general program chairman; Roger McCoy, chairman, Publicity; Robert W. Schlitzkus, chairman, Finance; Raymond C. Grassi, chairman, Technical Events; Robert Sibley, chairman, International Affairs; Robert Roth, chairman, Inspection Trips; C. Purves-Smith, chairman, Entertainment; Alf Hansen, chairman, Women's Program; and Fred Weir, chairman, Social Arrangements.

Make Hotel Reservations Early

Members planning to attend the meetings are urged to mail requests for room reservations immediately to the ASME Housing Committee, Room 200, 61 Grove Street, San Francisco, Calif. Blocks of rooms for ASME members have been set aside in the following hotels: Fairmont, Mark Hopkins, Sir Francis Drake, Fielding, Manx, Stewart, and Bellevue. Prices of rooms range from $7 to $12 for single room, $4.50 to $14 for double room, and $5.50 to $14 for twin-bed room. Suites are available at the Fairmont Hotel for $20 to $30. Room requests must be accompanied by a check for $5 per person if you plan to share a double room, or $10 for a room reservation. Because single rooms are limited, members will have a better chance of acquiring a room in the hotel of their choice if they plan to reserve a room to be shared by two or more persons. A room reservation form for convenience of members is shown below on this page. Requests will be handled chronologically by the Housing Committee. Reservations will be confirmed if requests are received by June 16, 1949.

Membership List Available

THE 1948 Membership List of The American Society of Mechanical Engineers was released in January, 1949, and is available free to members of the Society upon written request.

The Membership List contains photographs of Society officers and members of the Council, information about the Society, alphabetical and geographical list of members, and list of ASME student branches.

For purposes of economy only a limited number of copies of the 1948 Membership List was published. These will be distributed to officers and committee personnel of the Society and, while the supply lasts, to members who ask for copies.

Any Interest in These Inspection Trips?

Robert Roth, Chairman
Inspection Trips
3598 Galindo Street
Oakland 1, Calif.

I am interested in making the trips checked (√):

( ) Cutter Laboratories
( ) Pelton Water Wheel Company
( ) Petroleum Research Laboratory
( ) Winery
( ) Besler Boiler Corporation
( ) General Electric Transformer Plant
( ) General Electric Motor Plant
( ) Sugar Refinery
( ) San Francisco Mint
( ) Chinatown, San Francisco
( ) Muir Woods

Signed .....

Address .....

City .....

Hotel Room Reservation Request Form

MAIL TO: ASME Housing Committee, Room 200, 61 Grove St., San Francisco 2, Calif.

Please make Room Reservation noted: (Use hotels listed or other hotels)

1st Choice Hotel ..... Single Room @$.....
2nd Choice Hotel ..... Double Room @$.....
3rd Choice Hotel ..... Twin-Bed Room @$.....
OTHER TYPE ROOM ..... @$.....

Arriving Day ..... Date ..... at .....a.m. .....p.m.
Leaving Day ..... Date ..... at .....a.m. .....p.m.

Room will be occupied by

Name *Address*

.....
.....
.....

Check for $.....is enclosed to bind this reservation.

Signed .....

Address .....

City .....

(Deposits of $5 per person or $10 per room required with this form)

ASME Junior Forum

Compiled and Edited by a Committee of Junior Members, B. H. Edelstein, Chairman

Hired Technicians or Professional Engineers?[1]

ARE the graduates from today's engineering schools engineers or are they technicians? The man who calls himself an engineer in our present-day society must be a vastly different type of person from his counterpart of not too many years ago. Engineers of the past made their profession famous by their constant improvement of products, tools, and methods. Now, to their surprise, engineers find that a different kind of progress is required of them and that society is continually raising the requirements which a man must fulfill in order to be called an engineer.

It requires much more than the ability to design an efficient machine or a stable structure to be called an engineer in present-day society. Today's engineer must be a citizen in the fullest sense of the word; he must be active in civic affairs from local to national levels; he must possess the intangible qualities of leadership which are associated with an executive; he must possess a dynamic personality. Any self-styled engineer who does not possess these characteristics will not be called an engineer in our society, but instead he will be called a technician.

Did you ask, "What is a technician?" Sir Richard Livingstone has aptly defined a technician as a man who understands everything about his job except its ultimate purpose and its place in the order of the universe.

Now, consider an engineer. Can you define engineering? Perhaps one of the most widely accepted definitions of engineering hangs on the wall of the national headquarters of the Engineering Societies of New York and reads as follows: "Engineering is the art of directing men and controlling the forces and materials of nature for the benefit of the human race." You will note from this definition, by which society measures all engineers, that technical proficiency alone will not suffice in today's society.

Three Phases of Training

In order that a professional engineer may fulfill his obligations to society, his schooling must cover the three phases of his professional activity as outlined in the foregoing definition of engineering. In the first place, if an engineer is to "direct men," his background must contain a well-rounded program of personal development. He must develop the ability to organize and lead men, the ability to sell himself and his ideas, the ability to think and speak on his feet while under stress, and the ability to co-operate with others.

The question arises whether our engineering schools are today turning out graduates with well-rounded personalities and excellent character habits? Unfortunately, the intangibles of leadership, personality, and character are not to be obtained through continuous manipulation of the slide rule and long hours of academic study. As a matter of fact, the only way in which these qualities can be obtained in engineering school is through active participation in extracurricular activities.

The writer has made a survey of the extracurricular activities of engineering students at Oklahoma A & M College which showed that 36.1 per cent of the male students on the campus were engineers. Only in two types of organizations did the percentage of engineers begin to approach this base percentage of 36.1 per cent; which is to say that only in church and fraternal organizations do engineers avail themselves of the opportunity for personal development in proportionate ratio to the percentage of engineers on the campus. It was evident that engineers did not avail themselves of these extracurricular activities as a means of personal development. In fact, the actual number of engineers in each group was pitifully small compared to the engineering enrollment of 2649 students.

To place the study on a nation-wide basis, student participation in the Founder Societies was determined at 11 engineering colleges selected to represent all sections of the country. This showed that in only one school, the University of Illinois, were there more than one fifth of the engineering students taking advantage of the opportunities for professional development which membership in the Founder Societies make available. Here again it is seen that engineering students are not developing their character and personalities to the fullest extent.

Neglect of Opportunity

More evidence pointing to neglect of opportunity and disregard for the principles of democratic self-government was found in a study of the Village Council of the Oklahoma A & M College Veteran's Village. Here in a community of 4500 persons, of which 40.6 per cent were male engineering students, only 14.3 per cent of the male members of the Council were engineers.

In the social fraternities also, engineering students do not represent the strength of their numbers on the campus. At Oklahoma A & M College, where engineers represent 36.1 per cent of the student body, only 22.5 per cent of the fraternity men were engineers. Just the opposite is true of the commercial students, who compose 17.8 per cent of the student body but make up 29 per cent of the men in fraternities. The obvious conclusion is that students in schools other than engineering are more active in extracurricular activities than engineering students. This fact is having serious consequences as engineers graduate into the professional world.

Lee H. Hill, publisher of the *Electrical World*, goes so far as to say, "One of the main reasons manufacturers have developed graduate training courses has been that the young engineering graduate has had many rough corners to knock off and has needed to become accustomed to rubbing shoulders with other people." Here again it is seen that the engineering student is not developing his character and personality to the fullest extent.

Engineer's Curriculum a Burden

One of the main reasons for this lack of character and personality development of engineering students is the curriculum forced upon them. An analysis of college catalogs to determine the relative number of clock-hours required by the various curriculums, showed that the mechanical-engineering curriculum required 19.5 hours per week more than the accounting curriculum, and 10 hours more than the law curriculum. It is not surprising that the engineering student cannot find time for the character-development activities engaged in by students of other professions.

Thus it is seen that the engineering student of today is not developing his character and personality to the fullest extent, the main reason being the time required by a heavy technical curriculum.

Going back to the definition of engineering, it is obvious that an engineer's background must make him technically proficient in "the control of the forces and materials of nature." It can be conceded without argument that the technical proficiency of present-day graduates is sufficient when compared to their proficiencies in other fields.

The final stipulation made by society for engineers is that all their actions be "for the benefit of the human race." It is this stipulation that places the engineer of today in a truly professional status, for the true mark of any profession is its ministry to the human race. In order for engineers to measure up to this, their background must include a sound knowledge of subjects ordinarily associated with a liberal-arts education, such as history, philosophy, psychology, economics, and sociology. Those who doubt the value of this liberal-arts background need only to consult the long list of names of prominent engineers who have had no formal engineering education.

Engineering students today receive little instruction in the liberal arts. At Oklahoma

[1] 1948 ASME Undergraduate Award prize paper, by L. W. Ledgerwood, former student member ASME, Oklahoma A & M College, Stillwater, Okla. Slightly condensed.

A & M College, for example, engineering students get only one third of the time devoted to nontechnical subjects than do their brothers in the School of Law.

Thus the results of this analysis indicate that today's engineering students are receiving adequate instruction in only one of the three fields in which society will expect them to be proficient, namely, technical skill. The graduating engineer is far behind his contemporaries, who are graduating from other professional schools, in his ability to shoulder the obligations immediately thrust upon him by society. The graduating engineer is perilously close to being a technician, rather than an engineer.

One solution to the problem is to put engineering education on a full professional basis along with the other accepted professions. This would require at least three years' liberal-arts work before the student started his actual engineering work. The academic load should be lightened in engineering school in order to continue a well-balanced development of the student's character, morals, and knowledge. Yet, at the same time, the standards in engineering school would have to be raised to eliminate those students not capable of showing progress toward sound professional judgment. The current trend is a step in this direction.

Recently, at least four schools, the University of Minnesota, Cornell, Ohio State, and Rice, have changed to programs requiring five years work for an engineering degree. Educators and engineers in industry are realizing the necessity of turning out engineers who are well-rounded individuals in addition to possessing technical skills. Hence as one approach to the problem, experiments are being made with the new five-year type of curriculum. This type of curriculum is imperative if the divorce between knowledge and wisdom is to be set aside.

No better example is to be had of the divorce of knowledge and wisdom than in Germany during the Nazi regime. Germany's colleges turned out capable technicians in great numbers. These technicians possessed unique knowledge and skill, as their subsequent work testified. However, they were without wisdom, and it made no difference to them who employed them, or to what antisocial ends their highly developed knowledge was put. The result is known to everyone.

It is not enough for our engineers to possess knowledge; they must possess the wisdom with which to apply this knowledge. This wisdom can be born only during the well-balanced development of a professional education. When this is provided for the eligible youth of our nation, then, and only then will our schools graduate engineers who will continue to be a blessing to society.

L. W. LEDGERWOOD.

Engineers-in-Training

THE Committee on Engineers-in-Training of the National Council of State Boards of Engineering Examiners is attempting to develop a statement of objectives and a set of specifications dealing with engineering-in-training examinations, which will promote uniformity in such things as duration of examination, subject matter, where given, when, fees, and other related matters.

Describing the need for such a model program, H. L. Solberg, Mem. ASME, chairman of the NCSBEE committee, stated in the March issue of *The Registration Bulletin:*

"The number of men who will have been enrolled as engineers-in-training by July 1, 1949, will probably exceed five thousand. Some of these men are now applying for registration as professional engineers in states other than the state in which they were enrolled as an engineers-in-training, and the number of such applicants for registration will increase very rapidly during the next three years. These men are encountering complications and difficulties because of the lack of uniformity of standards and requirements that exist between states with respect to both registration and certification as an engineer-in-training.

"If the engineers-in-training program is to gain general acceptance and maximum effectiveness, it must be developed with due consideration to the fact that young engineers change jobs and residence quite frequently during the five-year period following graduation from college. Consequently, uniform standards and practices and general acceptance of the principle of reciprocity are essential to a well-developed program.

"It is anticipated that within ten years, if engineers-in-training program is properly developed, the majority of applicants for registration will be engineers-in-training."

The engineers-in-training program, now several years old, permits a young man graduating from an accredited engineering school to sit for the first part of the professional registration examinations dealing with fundamental engineering, at a time when he is best prepared to do so. A certificate is issued to successful candidates. Several years later, when the requisite experience has been acquired, he can qualify for the final examinations which cover practical application of engineering experience.

Comment

Job Opportunities

To the Editor:

I look forward to reading the Junior Forum each month. To me, it is the most interesting department in MECHANICAL ENGINEERING, because it is my only real connection with the trend of thinking and the activities of other members. To my knowledge, there are no other members of ASME here in the plant and there are no sections within 100 miles. Being without a car I am more or less isolated from contact with other mechanical engineers and the magazine is a great help.

I often wonder how many other engineers in relatively small communities are in the same boat.

I am in complete agreement with Mr. Adolph's comments in the February Forum on job opportunities. There are many positions open to young engineers, and the most expedient method of locating prospective employers is through the student placement bureau of the college or university from which the engineer has graduated.

I would venture to say that help along these lines could be obtained even if the applicant is a graduate of some other college or university.

In 1947 when I was working in New Jersey, I obtained wholehearted co-operation from Iowa State College in relocating in the Middle West even though I had graduated three years before. I am sure Mr. Weiss would find the same to be true at the University of Michigan, and that more than enough opportunities are still available to locate him in the type of work he prefers.

R. D. HUG.[1]

[1] Jun. ASME, W. A. Sheaffer Pen Company, Fort Madison, Iowa.

Activities of the ASME Executive Committee

At a Meeting at Headquarters, Feb. 25, 1949

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, Feb. 25, 1949. There were present: James M. Todd, chairman, T. E. Purcell, vice-chairman, E. J. Kates, Forrest Nagler, John H. Lawrence (Finance), K. H. Condit (Organization), K. W. Jappe, treasurer, E. G. Bailey, past-president, A. R. Mumford, vice-president, and C. E. Davies, secretary.

Executive Committee

Thomas E. Purcell, vice-president, ASME Region V, was elected vice-president of the Executive Committee of the Council.

Board on Public Affairs

On recommendation of the Organization Committee, appointment of the following as members at large on the Board on Public Affairs were approved: W. L. Batt, chairman, Walker L. Cisler, D. Robert Yarnall, A. A. Potter, and M. X. Wilberding.

Technical Committees

The following technical committees were discharged with thanks: Power Test Codes Committee No. 15 on Steam Locomotives; Sectional Committee B 41 on Hot Rolled Bars, Stock Sizes, Shapes, and Lengths for Hot and Cold Finished Iron and Steel Bars; and Sectional Committee B 50 on Unification of Rules for Dimensioning of Furnaces Burning Solid Fuel.

1950 National Meetings

The following national meetings were approved: Spring Meeting to be held at Hotel Statler, Washington, D. C., week of April 10.

Semi-Annual Meeting to be held at Hotel Statler, St. Louis, Mo., June 19-23; and Annual Meeting to be held at Hotel Statler, New York, N. Y., Nov. 27-Dec. 1.

Kansas City Section

Upon recommendation of Carl J. Eckhardt, vice-president, ASME Region VIII, with concurrence of the Mid-Continent and Kansas City Sections, the recommendation to transfer all members residing in the state of Kansas from the Mid-Continent to the Kansas City Section was approved.

Certificates of Award

Certificates of Award were approved for the chairmen of the following Sections: Burton F. Keene, Philadelphia Section; E. W. Jacobsen, Pittsburgh Section; and Louis P. LeBel, Hartford Section.

Dr. W. F. Durand

Cordial greetings and good wishes on the occasion of his ninetieth birthday on March 5, 1949, were extended to Dr. W. F. Durand.

Appointments

The following appointments were confirmed: Forrest Nagler, presentation of Washington Award, Chicago, Ill.; Burton F. Keene and C. B. Campbell, Annual Meeting of American Academy of Political and Social Science, Philadelphia, Pa.; William H. Carson, World Engineering Conference, Cairo, Egypt; and James M. Todd, representative; alternates, Frederick J. Graf and E. A. Grantiss, President's Highway Safety Conference, Action Program.

ASME Pittsburgh Section to Hold Annual Conference April 29, 1949

THE 1949 Mechanical Engineering Conference sponsored annually by the Pittsburgh Section of The American Society of Mechanical Engineers, will be held at William Penn Hotel, Pittsburgh, Pa., April 29, 1949.

The following societies are co-operating in the conference: Engineers' Society of Western Pennsylvania and the Pittsburgh Sections of the Society for the Advancement of Management and the American Materials Handling Society.

James M. Todd, president ASME, has accepted an invitation to attend the conference which is planned to provide Pittsburgh members who are unable to attend ASME national meetings with a program of equal caliber.

Student members from the University of Pittsburgh, Carnegie Institute of Technology, and the University of West Virginia have been invited to present papers at each of the sessions.

At the Carnegie Institute of Technology, where the student branch was invited to present a paper on "The Forming of Metals," so many students volunteered for the job that a competition was organized and a committee was formed to select the best paper.

The conference will consist of four technical sessions: synthetic fuels, management, metalworking, and materials handling. The final event will be a banquet at which Pres. James M. Todd will be honored guest and principal speaker. As part of the banquet ceremonies, four Fellow certificates and a meritorious service award will be presented to members of the Pittsburgh Section.

The program follows:

Synthetic Fuels Session

9:00 a.m.

Paper on Fuels, by student, University of Pittsburgh Student Branch

Production of Synthesis Gas (author to be announced)

Production of Synthetic Fuels, by Martin Elliott, assistant supervisor, U. S. Bureau of Mines, Bruceton, Pa.

Management Session

Paper by student, University of Pittsburgh Student Branch

Work Simplification, by E. L. Schleufner, vice-president in charge of manufacturing, F. C. Russel Company, Cleveland, Ohio

Tools and Technique, by H. B. Shaw, Methods Engineering Council, Pittsburgh, Pa., and president, Pittsburgh Chapter of SAM

Metalworking Session

The Forming of Metals, by student, Carnegie Institute of Technology Student Branch

Cold Extrusion of Steel, by W. J. Meinel, president, Heintz Manufacturing Company, Philadelphia, Pa.

Extrusion of Heated Billets, by Karl Feller, president, Feller Engineering Company, Pittsburgh, Pa.

Materials-Handling Session

History of Materials Handling, by student, West Virginia University Student Branch

New Development in Coal Handling at Mine Face, by W. L. Wearly, vice-president, Joy Manufacturing Company, Pittsburgh, Pa.

Materials Handling in the Refractory Industry (author to be announced), Harbison Walker Company, Pittsburgh, Pa.

Banquet

6:30 p.m.

Chairman: H. H. Hall, chairman, Pittsburgh Section ASME

Toastmaster: T. E. Purcell, vice-president, ASME Region V

Speaker: James M. Todd, president ASME

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Akron-Canton, Dec. 16. Speaker: Paul W. Fuller. Subject: Trends in Labor Peace. Attendance: 70.

Jan. 27. Speaker: Oscar Loudenslager. Subject: Cross-Wind Landing Gear. Attendance: 78.

Boston, Feb. 24. Speaker: C. Fayette Taylor. Subject: Internal-Combustion Engines. Attendance: 176.

Central Pennsylvania, Jan. 18. Joint meeting with Center County joint subsection AIEE-IRE. Speakers: Roland E. Mueser and George M. Dusinberre. Subjects: Jet-Propulsion and Gas-Turbine Applications.

Feb. 7. Joint meeting with Williamsport Group, SAE. Speaker: Max M. Roensch. Subject: Design for Past, Present, and Future Fuels. Attendance: 40.

Chattanooga, Feb. 11. Speaker: W. B. Browning. Subject: Industrial Oxygen. Attendance: 85.

Chicago, Jan. 18. Joint meeting Oil and Gas Power Division and Railroad Division. Speaker: Warren A. Thomas. Subject: Formula of a Diesel Locomotive. Attendance: 40.

Junior Group, Jan. 12. Speaker: Carl Zersen. Subject: From Flame to Fluorescence. Attendance: 74.

Cleveland, Jan. 13. Speaker: James Robinson. Subject: Hydraulic Circuit Design. Attendance: 85.

Feb. 10. Speaker: F. R. Benedict: Subject: Future Methods of Power Generation.

Fairfield County, Feb. 15. Speakers: W. Schidt, E. Scull, and C. Helmle. Subject: Hard Chromium Plating in Engineering. Attendance: 101.

Greenville, Dec. 13. Joint dinner meeting with Engineers' Club of Western North Carolina. Speaker: Julian E. Tobey. Subject: Bituminous Coal and Its Future. Attendance: over 100.

Kansas City, Feb. 14. Speaker: F. R. Gruner. Subject: Background and Future Use of Atomic Energy. Attendance: 83.

Milwaukee, Feb. 9. Speakers: H. B. Lammers and J. E. Brown. Subject: Smoke Abatement. Attendance: 55

New Orleans, Feb. 10. Speaker: Sam G. Dukelow. Subject: Fundamentals of Flow Metering. Attendance: 48.

North Texas, Feb. 1. Speaker: W. B. Gregory. Subject: Steam for Power. Attendance: 61.

Oregon, Jan. 21. Joint meeting with Oregon State College branch. Speaker: Harry M. Banfield. Subject: Personnel Problems. Attendance at dinner: 44.

Feb. 11. Speaker: D. T. Morganthaler. Subject: Feedwater Control for Modern Power-Plant Boiler. Attendance: 38.

Philadelphia, Feb. 18. Speaker: C. S. Kirkbridge. Subject: New Developments in the Petroleum Industry. Attendance: 101.

Wilmington Subsection, Feb. 16. Speaker: J. H. Harlow. Subject: Engineering Features of Southwark Electric Station. Attendance: 64.

Pittsburgh, Dec. 6. Speakers: T. F. Hatch and J. M. Rice. Subject: Professional-Engineering Registration. Attendance: 450.

Rock River Valley, Feb. 25. Speaker: J. G. Oetzel. Subject: Electrically Actuated Friction Brakes and Clutches. Attendance: 42.

Schenectady, Feb. 17. Speaker: W. L. Knaus. Subject: Heat-Pump Air Conditioners. Attendance: 50.

Southern California, Feb. 8. Speaker: Raymond Springfield. Subject: Recent Developments in the Rubber Industry. Attendance: 30.

Feb. 9. Speaker: M. F. Behar. Subject: Fundamentals of Instrumentation. Attendance 120.

Southern Tier, Feb. 28. Speaker: F. G. Tatnall. Subject: Physical Testing for Efficient Design of Machine Parts. Attendance: 65.

Susquehanna, Feb. 14. Speaker: Victor Civkin. Subject: Engineering in Home Construction. Attendance: 36.

Tri-Cities, Feb. 22. Speaker: John Hoffman. Subject: Foundry Mechanization. Attendance 42.

Virginia, (*Peninsula Chapter*), Feb 7. Joint meeting with Engineers Club of the Virginia Peninsula. Speaker: T. L. McLaughlin. Subject: Heat Pumps. Attendance: 200.

Worcester, Feb. 2. Speakers: George Motherwell and Arthur Lowery. Subject: Forging Practice of Wyman-Gordon Co. Attendance: 40.

Youngstown, Feb. 10. Speaker: J. T. Rettaliata. Subject: Gas Turbines. Attendance: 96.

Student Branch Activities

Reports of the following ASME student branch meetings were received recently at Headquarters:

University of Akron, Feb. 10. Speaker: J. J. Loge. Attendance: 25.

Feb. 28. Film: Steam for Power. Attendance: 26.

Alabama Polytechnic Institute, Feb. 7. Speaker: John Cotney. Subject: Vermiculite. Attendance: 70.

University of Arizona, Jan. 6. Speaker: John Joynt. Subject: Car of the Future.

Jan. 27. Speaker: J. R. Fruitman. Subject: Operation and Design of Turbojets, Ramjets, and Rockets. Attendance: 210.

Feb. 10. Speaker: W. C. Williams. Talk illustrated with film on lubrication. Attendance: 47.

Feb. 24. Film on Jet Propulsion. Short talk by Mr. Bullock on training program of Allis-Chalmers Mfg. Co. Attendance: 42.

University of California, Jan. 5. General meeting. Attendance: 159.

Jan. 15. Field trip to Friden Calculating Machine Co., San Leandro, Calif. Attendance: 15.

Case Institute of Technology, Feb. 8. Speaker: R. Dirks. Subject: Job Interviews for Graduating Seniors. Attendance: 110.

Clemson College, Feb. 8. Election of officers. Attendance: 52.

Feb. 22. Speaker: R. L. Allen, Jr. Subject: Continuous Casting of Steel. Attendance: 44.

Colorado A and M College, Feb. 2. Motion picture on copper processing. Attendance: 62.

University of Colorado, Feb. 9. Speaker: Mr. Myers. Subject: Protection of Pressure Equipment With Rupture Disks. Attendance: 50.

University of Connecticut, Feb. 15. Speaker: F. M. Gunby, vice-president, ASME Region I. Subject: The Engineer and His Ethics. Attendance: 125.

Columbia University (*Mechanical Division*), Feb. 7. Film: Steam for Power. Attendance: 75.

Cornell University, Feb. 10. Speaker: P. T. Elliott. Subject: The Opportunities of Machine Design. Attendance: 98.

Feb. 17. Speaker: Harold G. Vogt. Subject: New Developments in Glass. Attendance 117.

Duke University, Feb. 8. Speaker: Mr. Tanning. Subject: Head-End Power. Attendance: 30.

Feb. 16. Speaker: Otto de Lorenzi. Subject: Relation of Stoker Feeds to Coal Bed and Relation of Air Feed to Coal Bed. Attendance: 22.

Feb. 22. Paper by Julian Warren on Maintenance Engineering. Film: Lubrication Oils. Attendance: 23.

University of Florida, Feb. 15. Film: Frequency Modulation. Attendance: 48.

Georgia Institute of Technology, Feb. 18. Dinner meeting with Atlanta Section ASME. Speaker: C. L. Marquez. Subject: Functional Design of Steam-Generating Equipment. Film: Steam for Power. Attendance: 82.

Feb. 22. Three student papers presented. Attendance: 102.

University of Idaho, Feb. 21. Two films: Steam for Power, and Construction of Steam Generator Plants. Attendance: 41.

Kansas State College, Feb. 10. Speaker: Arthur Mortimer. Subject: Machine Design as a Career. Attendance: 125.

Feb. 17. Speaker: C. E. Roush. Subject: Engineer's Job, Type of Salesman and His Duties, and Engineer's Studies. Attendance: 235.

University of Kansas, Feb. 10. Speaker: Arthur Mortimer. Subject: Opportunities in the Field of Machine Design. Attendance: 125.

University of Kentucky, Jan. 13. Joint meeting with AIEE. Speaker: Mr. Askem. Subject: Electronics.

Feb. 17. Speaker: Mr. Popp. Subject: The Opinion Meter.

Lehigh University, Feb. 17. Speaker: C. I. Baker. Subject: Plant Location and New Methods of Production. Attendance: 100.

Louisiana State University, Jan. 4. General business meeting. Attendance: 71.

Michigan State College, Jan. 12. Speaker: Thomas S. McEwan. Subject: Management Problems. Attendance: 56.

Jan. 26. Speaker: Arthur F. Underwood. Subject: Bearings and Metals Used in Their Manufacture. Attendance: 65.

University of Michigan, Feb. 16. Speaker: R. G. Dailey. Subject: The Plastics Industry. Attendance: 100.

University of Minnesota, Feb. 9. Speaker: Josef Brozeck. Subject: Conditions in Czechoslovakia. Attendance: 87.

Mississippi State College, Feb. 17. General business meeting. Attendance: 50.

University of Missouri, Feb. 14. General business meeting. Attendance: 68.

University of Nebraska, Feb. 2. Joint meeting with student branch AIEE. Speaker: R. M. Ryan. Subject: Duties of an Application Engineer.

Feb. 16. Speaker: W. T. Delcour. Subject: The Way Over the Mountain, description of use of conveyer belts in building the Anderson Ranch Dam.

University of Nevada, Feb. 24. Speaker: Dr. Harris. Subject: Photomicrography. Attendance: 16.

New Mexico State College of A and M Arts, Feb. 11. Election of officers. Attendance: 30.

Feb. 17. Two films shown: Art of Generating and Gear-Manufacturing Equipment. Attendance: 45.

University of North Dakota, Feb. 16. Election of officers. Speaker: Keith W. Blinn. Subject: Taft-Hartley Act. Attendance: 26.

Northeastern University, Jan. 10. Field trip for juniors to Boston Edison Mystic Plant central station. Attendance: 20.

Jan. 11 and 18. Field trip for seniors to Lynn River Works Turbine Plant of General Electric Company. Attendance: 64.

Jan. 14. Annual Flywheel Frolic. Attendance: 90 couples.

Northwestern University, Feb. 8. Film: Steam Progress. Attendance: 35.

Ohio State University, Feb. 10. Business meeting. Films on atomic energy and high-speed photography. Attendance: 31.

University of Oklahoma, Feb. 2. Speakers: J. A. Taylor and C. C. Willis. Subjects: Power By Which We Live: Plant Efficiencies and Binary Cycles. Film: Power By Which We Live. Attendance: 100.

Feb. 16. Speaker: R. E. Stagg. Subject: The Soap Industry. Attendance: 35.

Pennsylvania State College, Feb. 15. Presentation of student papers. Attendance: 35.

Princeton University, Feb. 24. Joint meeting with Rutgers University branch. Speaker: James M. Todd, president, ASME. Attendance: 70.

Purdue University, Feb. 22. Joint meeting with SAE. Speakers: Mr. McCauley and Mr. Paul. Subject: Diesel Engine. Attendance: 150.

Feb. 24. Five student papers presented. Attendance: 50.

Feb. 26. Field trip to plant of Inland Steel Co., Indiana Harbor, Ind. Attendance: 65.

Rensselaer Polytechnic Institute, Feb. 17. Speaker: Lieut. Larsen. Subject: Gas Turbines. Attendance: 112.

Rhode Island State College, Jan. 6. Speaker: Otto de Lorenzi. Subject: Fuels and Firing. Attendance: 80.

Feb. 17. Speakers: Mr. Achorn and Mr. Hilner. Subject: Lubricating Oils. Film: The Inside Story. Attendance: 65.

Rice Institute, Feb. 14. Technicolor film: Oil. Attendance: 40.

University of South Carolina, Jan. 19. Presentation of charter to the branch. Speakers: E. E. Williams, past vice-president, ASME Region IV, and L. Zsuffa, Mem. ASME.

Feb. 9. First meeting of spring semester. Attendance: 42.

Feb. 23. General business meeting. Attendance: 52.

South Dakota State College, Feb. 16. Film: Industrial Organization and Management. Attendance: 42.

University of Southern California, Feb. 17. First meeting of the spring semester. Attendance: 92.

Stanford University, Jan. 27. Guests were a visiting group from Northern California Section of SAE. Presentation of three papers on technical subjects by students from Santa Clara University, California State Polytechnic College, and Stanford Unversity.

Feb. 8. Informal meeting at home of Prof. L. S. Jacobsen. Attendance: 35.

University of Tennessee, Jan. 26. Speaker: David Larkin. Subject: Civic Responsibilities of the Engineer. Attendance: 26. Evening of same day a joint meeting with the East Tennessee Section ASME was held. Speaker: David

Larkin. Subject: Manufacture of Wire Rope. Attendance: 125.

Feb. 9. Speaker: Mr. Daves. Subject: Application of Engineering in Plant Engineering. Attendance: 17.

University of Texas, Feb. 21. Organizational meeting to plan for spring semester. Film: 1949 Orange Bowl Game. Attendance: 61.

Virginia Polytechnic Institute, Jan. 11. Film: Steam for Power. Attendance: 204.

Jan. 18. Film: Masters of Molecules. Attendance: 228.

Jan. 25. Speaker: D. Allshouse. Subject: History and Development of Feedwater Regulation. Attendance: 219.

Feb. 1. Joint meeting with other engineering-society student branches. Film: Highway U. S. A.

Washington University, Jan. 3. Election of officers.

Feb. 7. Preview of spring activities.

Feb. 21. Films: I. C. Engines, and Earth-Moving Equipment.

University of Washington, Jan. 20. Films: Quality Control, and Service Procedure. Attendance: 60.

Wayne University, Feb. 23. Speakers: Harry L. Murray and Harry Hay. Subject: Job Shop Engineering. Attendance: 65.

Worcester Polytechnic Institute, Feb. 16. Speaker: Robert G. Dexter. Subject: Production Possibilities With Tailor-Made Automatic Machinery. Attendance: 94.

March 8. Speaker: S. W. Jones. Subject: Place of Plastics in Industry. Attendance 25.

University of Wyoming, Jan. 27. General business meeting. Attendance: 32.

Yale University, Feb. 16. Speaker: Prof. H. L. Seward. Subject: Story of the Normandie. Attendance: 60.

ASME Sections

Coming Meetings

Akron-Canton: April (no date). Student Branch Competition for ASME Regional Conference.

Anthracite-Lehigh Valley: April 22. Wilkes-Barre Meeting. Subject: Nondestructive Supersonic Testing. Speaker to be announced.

Atlanta: April 15. Atlanta Women's Club—Dinner Meeting (formal, wives invited) at 6:30 p.m. Talk by J. M. Todd, president, ASME. Introduction by Paul R. Yopp.

Baltimore: Ladies' night. Talk by Paul B. Eaton on his China experiences and ASME vice-presidential duties.

Boston: April 28. Section Meeting. Subject: Theory and Industrial Applications for Sonic Energy. Speaker from Ultrasonic Corp. to be announced.

Chattanooga: April 8. Maypole Restaurant. Dinner Meeting at 6:30 p.m. Subject: The Diamond Utiliscope (Boiler Water Level Gage), by John E. Fearron, representative, Boiler Equipment Service Co., Atlanta, Georgia.

Central Indiana: April 22. Purdue Memorial Building, West Lafayette at 6:30 p.m. Section Meeting. Subject: Election of Section officers. Undergraduate technical paper by student winner of Annual ASME Speech Contest. Papers by Purdue graduate students on current research work on the campus in rockets, machine design, and fluid mechanics. (This is the Annual Meeting with the Purdue University Student Branch). Speaker to be announced.

Cincinnati: April 7. Engineering Society Building. Section Meeting. Speaker: Col. James Walsh, American Ordnance, Mills Building, Washington, D. C.

Cleveland: Ladies night. 7:30 p.m. General Electric Institute, Nela Park. Tour through Institute to see latest developments in lighting.

Hartford: April 19. Executive Committee Meeting at the Hartford Club.

Kansas City: April 11. University Club. Dinner at 6:30 p.m. Meeting at 8 p.m. Subject: Manufacture of Jet Engines, by S. S. Stine, plant manager of Westinghouse Manufacturing Co.

Metropolitan Section: April 6. General Interest Meeting, Room 502[1] at 7:30 p.m.

April 7. IIRD, Room 1101[1] at 7:30 p.m. Subject: The Zero Reader, by Spencer Kellogg and Caesar Fragola, Sperry Gyroscope Co.

April 14. Woman's Auxiliary, Museum of Modern Arts, 11 West 53 St., New York, N. Y. at 1:30 p.m. and Tea, $1.25.

April 19. Engineers' Forum, Room 1101[1] at 7:30 p.m. Subject: Being an Active ASME Member.

April 21. Materials Handling Forum, Room 1101[1] at 7:30 p.m.

April 22. Machine Design Division, Room 502[1] at 7:30 p.m.

April 27. New Jersey Division, Bayway Refinery of the Standard Oil Co., Linden, N. J., at 2:00 p.m. Conducted tour.

April 28. Metropolitan Section Spring Round-Up, Waldorf-Astoria Starlight Roof. Cocktail Hour 6 p.m. to 7 p.m. Dinner at 7 p.m. followed by entertainment.

Minnesota: April 6. Annual ASME dinner for members and wives. Subject: Modern Homes for Better Living. Motion pictures and speaker from the Weyerhaeuser Sales Co.

New Orleans: April (no date). Meeting will be sponsored by the student group at Tulane University and will possibly feature a forum on engineering instruments with discussions and demonstrations by the students.

Ontario: April 14. Music Room, Hart House, at 8 p.m. Subject: Power Generation, by Prof. A. G. Christie, Johns Hopkins University.

Peninsula: April 12. Plant inspection trip.

Philadelphia: April 12. Engineers Club at 7:30 p.m. Junior Meeting. Subject: Product Design. Speaker to be announced.

April 19. Towne School, University of Pennsylvania. Professional Division Meeting. Subject: Iron Powder Metallurgy, by Claire Balke, Roberts and Manders Co.

April 26. Engineers Club, 1317 Spruce Street, at 7:30 p.m. Subject: Residential Heat Pumps, by C. Barry, rate research engineer, Philadelphia Electric Co.

Plainfield: April 20. Elks' Club, Elizabeth, N. J., at 8:15 p.m. Subject: Science in Gardening, by Prof. Henry Biekart, College of Agriculture, Rutgers University.

St. Louis: April 22. Section Meeting. Subject: Diesel Locomotive Operation With Laboratory Control, by Wayne Lasky, engineer of tests, GM&O Railroad.

San Francisco: April 7. (Meeting with the American Society of Heating and Ventilating Engineers as host.) Engineers' Club, 206 Sansome Street. Dinner Meeting at 6:30 p.m. Regular Meeting at 7:45 p.m. Subject: Recent Developments and Installations of Heat-Pump Air-Conditioning Systems, by Frank W. Jordan, Pacific Coast district manager, Sturtevant Division, Westinghouse Electric Corp.

San Diego Sub-Section (Southern California Section). April 20. San Diego Women's Club. Refreshments. Subject: Application of Sprayed Metal, by Bertram Smith, Metco Co.

April 27. Inspection trip through the A. B. C. Brewery, San Diego. Conductor, E. R. Prout. Guide, Charles Geiger.

Southern California: April 6. Professional Division. Southern California Edison Building, Room 214, 601 West 5th Street. Subject: Planning for 1950 Section Activities, by J. S. Earhart.

April 6. Hydraulic Division. California Institute of Technology, Mechanical Engineering Building, Pasadena. Subject: Water Works, Specifications, Design, and Manufacturing, by R. E. Hemberg.

April 13. Photographic Division. Southern California Edison Building, Room 214, 601 West 5th Street. Subject: Recent Developments in Flight-Test Recording Camera, by A. K. Warner.

April 13. Hydraulic Division. California Institute of Technology. Mechanical Engineering Building, Pasadena. Subject: Pump Theory and Practice, by H. H. Brown.

April 20. Hydraulic Division. California Institute of Technology, Mechanical Engineering Building, Pasadena. Subject: Piping Design and Layout, by Dr. P. Kyropoulos.

April 20. Management Division. Southern California Edison Building, Room 214, 601 West 5th Street. Subject: Systematization, by E. Fabary.

April 27. Hydraulic Division. California Institute of Technology, Mechanical Engineering Building, Pasadena. Subject: Basic Theory and Application of Hydraulic and Pneumatic Systems, by J. P. Clark and J. S. Newton.

April 28. General Division. Southern California Gas Auditorium, 810 S. Flower Street. Joint Meeting of Southern California Section of the American Rocket Society and the Southern California Section of ASME. Subject: The Status and Direction of German Rocket Development at the End of World War II, by Dr. W. Riedel.

April 28. Steam Power Division. Southern California Edison Auditorium, 601 W. 5th Street. Subject: Power Generation, by J. W. McPherson and M. M. Patterson.

Youngstown: April 14. Dinner Meeting. Joint Meeting with the AIEE Sharon Section and AWS, Mahoning Valley Section. Hosts: ASME. Subject: The Engineering Revolution or The Application of Electronics to Testing, by F. G. Tatnall, The Baldwin Locomotive Works.

April 28. Professional Division Meeting. Power (Fuels, Oil and Gas Power, Steam Power). Speaker and subject to be announced

[1] Engineering Societies Building, New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER desires responsible position; over twenty years supervision plant operation and maintenance, industrial construction, plant layout, estimating, and sales. Good liaison man for busy executive or in charge of modernization program. Me-389.

PRODUCTION ENGINEER, BSME, MSIE, two years' experience with manufacturing methods, time studies, costs, design, and supervision. Capable of assuming responsibility. Desires connection with progressive firm. Me-390.

MECHANICAL EXECUTIVE ENGINEER, with eleven years' supervisory experience; thoroughly familiar with tool engineering, estimating, methods, costs, and budgetary control, any type of metal fabrication and finishing. Me-391.

LAWYER-ENGINEER, BSME, LLB, recent graduate Harvard Law. Three and a half years' practical engineering experience in civil, mechanical, and marine engineering. Desires a position in law or executive engineering. Me-392.

MECHANICAL ENGINEER, 29, married, with four years' experience diversified process engineering; three years' general mechanical design. Equally interested in sales or management opportunity. Available immediately. Central and southern California. Me-393-491-D-8.

EXECUTIVE with background of product engineering, sales production, cost-reduction programs, accounting, and standardization and control of functional operations; desires position as general manager of aggressive company manufacturing medium-heavy machinery. Me-394.

INDUSTRIAL ENGINEER, BSME, 26, married, taking graduate study in industrial engineering, two and a half years' experience in methods, time study, inspection. Prefers eastern U. S. Me-401.

MECHANICAL ENGINEER, 26, married, BSME. Four years' power-plant experience as marine engineer, holding first assistant steam and third assistant Diesel license. One year's drafting experience in airplane plant. Available immediately. Location immaterial. Me-402-493-D-1.

STUDENT MECHANICAL ENGINEER, 26, married, BSME, graduated June, 1948, Navy veteran, interested in manufacturing or production supervision training with an industrial firm. Northeastern area. Me-395.

INDUSTRIAL ENGINEER, 26, BA, BS in IE, Lehigh honor graduate; twenty-eight months chief engineer navy ship; eighteen months' construction experience, adaptable. Desires trainee or junior IE position in New York metropolitan area. Me-396.

ENGINEERING EXECUTIVE, 36, married, Cal-Tech graduate; thirteen years' experience. Seven years metalworking and tool industry as chief engineer and manager in charge of production, engineering, and sales. Extensive carbide-tool and machine-shop experience. Six years with large electric utility on electrical, mechanical, and power-plant engineering. Location immaterial. Me-397.

INDUSTRIAL ENGINEER, BSME, graduating MS in IE June. Seeks employment of diversified nature with progressive organization; prefers Chicago area, but will go anywhere. Me-398.

FACTORY EXECUTIVE, MSME, licensed PE, also cost accountant. Twenty-two years' extensive manufacturing experience including production, supervision, and planning, sales forecasts, budgets, and cost reduction through improved methods and product redesign. Me-399.

MECHANICAL ENGINEER, 39, married, ME Cornell; thirteen years' design, development, liaison in electromechanical, structural, machine-design, and chemical fields. Desires responsible position as chief development engineer or technical staff position. Location other than N. Y. metropolitan area preferred. Me-400.

POSITIONS AVAILABLE

SENIOR MECHANICAL ENGINEER, graduate, with not less than ten years' experience in design and operation of hydraulic turbines, penstock valves, and associated power-plant accessories. Work involves mechanical-plant layout, preparation of specifications, examination of manufacturers' drawings, and inspection of equipment. Salary open depending on qualifications. Canada. Y-1721.

PLANT ENGINEER, 40-45, mechanical graduate, with steel-and-wire mill experience, to take charge of maintenance, planning, new installations, and construction of furnaces, rolling and wire-drawing facilities, etc. Salary, $5000-$6000. New York Metropolitan Area. Y-2110(a).

TOOL AND DIE DESIGNER, 35-45, with at least ten years' general shop experience, to take charge of tool and die design, and supervision of engineering for manufacturer of stationery accessories. Salary, $6000-$8000. New York, N. Y. Y-2133.

TECHNICAL EDITOR, mechanical graduate, 28-32, with technical-writing experience either with publishing or industrial company, to prepare general-engineering, manufacturing, and process articles. Must know Spanish and have traveled in Latin America. $5200. New York, N. Y., occasional trips. Y-2134.

ENGINEERS. (a) Assistant engineer, mechanical, with at least five years' experience in instrument design, to translate work for designers and draftsmen. Any radar experience helpful. $6000. (b) Junior engineer with two to three years' experience in: (1) stress analysis for mechanical structures; (2) vibration test and calculations. Salary open. Upstate New York. Y-2139.

MECHANICAL OR ELECTRICAL ENGINEER, 30-40, graduate, preferably electrical, with about ten years' experience in heavy industrial-plant operation in cement or similar plants. Position permanent. $5000-$6000, depending on qualifications. Upstate New York. Y-2150.

ENGINEERS. (a) Mechanical engineer with degree and experience in supervising draftsmen who will be designing small mechanisms. $6000-$7000. (b) Production engineer, mechanical graduate, with experience in the engineering of the mechanical phases of products, to simplify manufacture and to reduce costs. Some supervisory duties involved. $4000-$5000. Connecticut. Y-2166.

SHOP SUPERVISOR, 35-55, preferably mechanical graduate, with broad machine-shop and maintenance experience covering presses, dies, stampings, etc., to perform master-mechanic duties in sheet-metal-products manufacturing plant. Up to $5700. East. Y-2179.

PLANT ENGINEER, 35-50, with at least ten years' supervisory experience covering maintenance and operation of steam-power-plant and manufacturing equipment, to take charge of power plant and machinery for lumber-products manufacturer. $5000-$6000. New Hampshire. Y-2189.

METHODS ENGINEER, 35-40, to be in charge of new department on machine layout, materials handling, design, etc. for large woolen textile mill employing 3000-4000 people. $7500. Northern New Jersey. Y-2190.

MACHINE DESIGNERS WITH MINIMUM OF ten years' experience, preferably in packaging machinery, etc. Permanent. $7200-$8400. New York Metropolitan area. Y-2192.

(*ASME News continued on page 374*)

[1] All men listed hold some form of ASME membership.

A COMPLETE SYSTEM...

FOR INSTANT, ACCURATE CHECK ON LIQUID OR BOILER WATER LEVELS THROUGHOUT THE PLANT

Yarway Remote Liquid Level Indicator with Control Unit attached.

Now you can have constant check-up on water levels wherever —and whenever—you want.

The Yarway Liquid Level Indicator, equipped with Yarway Control Unit and auxiliary electric signalling devices, provides this check at two or more locations anywhere in the plant.

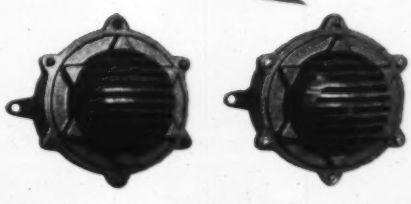
The Yarway Indicator is always accurate because it is operated by the liquid itself. Indicating mechanism is never under pressure. There are no stuffing boxes. Complete separation of indicating and actuating parts is achieved by permanent magnet transmission.

The Automatic Control Unit is attached directly to the Indicator and operates the remote signal alarms (light or horn) at any remote locations.

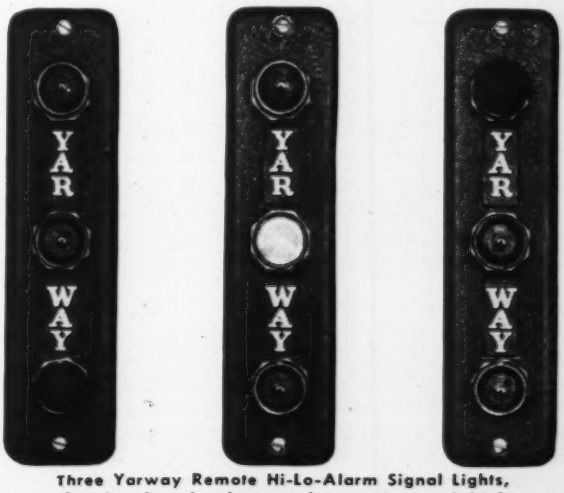
The Control Unit may also be used as a control for mechanical equipment such as motor-operated valves, pumps, etc.

FOR COMPLETE DESCRIPTION AND SPECIFICATIONS OF YARWAY REMOTE LIQUID LEVEL INDICATORS, WRITE FOR BULLETIN WG-1822.

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.



Yarway Remote Hi-Lo-Alarm Signal Horns.



Three Yarway Remote Hi-Lo-Alarm Signal Lights, showing low level, normal operation and high level. Each unit shows all levels.

YARWAY REMOTE LIQUID LEVEL INDICATOR

DESIGN ENGINEER, 26–40, mechanical degree or equivalent, preferably with five years' experience in the design of parts of molded bakelite, die castings, powdered metal, pressed metal, etc., as well as some experience in factory work, and understanding of the use of machine tools. Nearly 100 per cent board work. Opportunity for advancement. $5000. Northern New Jersey. Y-2210(b).

DESIGN ENGINEER with at least five years' automotive-accessories experience, to design for production gages, hose accessories, compressed-air tanks, fittings, and other garage and service-station items. $5000, plus bonus. New York, N. Y. Y-2220.

FACILITIES ANALYST "A," preferably college graduate with technical training suitable for manufacturing work. This could be industrial and mechanical engineering, or business-administration courses in which applicant had been exposed to the problems of industrial and plant engineering. Experience should include at least five years and preferably more in a line manufacturing operation in which applicant had been exposed to major phases of a manufacturing operation, preferably automotive, and who has also spent time on a staff level engaged in the preparation of reports to top management having to do with manufacturing activities. Should possess report-writing ability. Salary $8000–$10,000. Michigan. D-4735.

SALES ENGINEER, mechanical, 35–45; eight to fifteen years' experience in sale of mechanical products to industrial and commercial users. Must have application knowledge of mechanical power transmission, gears, speed reducers, roller bearings, cushion blocks, ship hoists, and car pullers. $4500–$7000, plus bonus and expenses. Territories, eastern Ohio, western Pennsylvania, and West Virginia. Headquarters, Pittsburgh, Pa. R-5543.

PROCESS ENGINEER, 30–40, mechanical graduate, with alloy metals, methods, and processing experience, to devise machining and fabrication of nonferrous metals. $6000–$7000. Upstate New York. Y-2225.

FILTER ENGINEER wanted by reputable Midwestern automotive-equipment manufacturer to design filters and cartridges. Excellent opportunity. Give complete details in first letter. Y-2227.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after April 25, 1949, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KET TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatment and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ACKERMAN, A. J., São Paulo, Brazil
AMIS, BUDDY P., Dallas, Texas
AMOS, STEPHEN E., Wilmington, Del. (Rt & T)
BARKER, STEPHEN, St. Georges Terrace, Perth, W. Australia
BECKER, JULES SNYDER, Elkins Park, Pa.
BEESLEY, GLYN, Dallas, Texas
BETTS, WILLIAM LUCAS, Philadelphia, Pa.
BLYTHE, BEN F., Sloatsburg, N. Y.
BOSCH, TONY, JR., Toledo, Ohio
BOYD, HUGH, 3RD, Hatboro, Pa.
BROSS, W. L., Greenwood, S. C.
BROW, RAY A., Los Angeles, Calif.
BURMA, DAVID, Toronto, Ont., Can.
CAMPBELL, HARRY A., N. Tonawanda, N. Y.
CANTIENY, AUGUSTO G. W., New York, N. Y.
CARLETON, JOHN V., Berwick, Pa.
CRAMER, CHARLES W., Trenton, N. J.
DASS, SUDHANSU KUMAR, Dalmianagar, Bihar, India
DAVIS, W. KENNETH, Hinsdale, Ill.
DEGRUMMOND, ERNEST A., Baton Rouge, La.
DE REMER, E. M., San Marino, Calif.
DIMITRIADIS, PETRO, Iowa City, Iowa
DINE, ROBERT E., Columbus, Ohio
DOHNA, ALFRED ERIC, E. Haven, Conn.
DOMBROWSKI, BRINEY S., Seneca Falls, N. Y.
DUCAT, KENNETH H., Chanute Air Force Base, Ill.
FEENER, DONALD H., Orono, Me.
FLEISHAUER, F. W., New York, N. Y.
FLETCHER, JOSEPH C., JR., Philadelphia, Pa.
FORCKE, E. W., Elmont, Va.
FORTNER, C. P., Arlington, N. J.
FOX, ARTHUR BONHAM, Rochester, N. Y.
FRISCIA, JOSEPH MARTINO, Los Angeles, Calif.
GARRETSON, PHILIP F., Glenside, Pa.
GASKILL, FRANK ORVILLE, Bronxville, N. Y.
GEIGER, JAMES A., Philadelphia, Pa.
GENSMAN, LEE R., Lake Grove, Ore.
GIBSON, W. E., Torrance, Calif.
GILLERMAN, HARVEY M., University City, Mo.
GLASCOCK, JOSEPH K., Birmingham, Ala.
GOULD, GLENN L., New York, N. Y.
GOULD, PAUL, Los Angeles, Calif.
GRAFF, ROLAND W., Cleveland, Ohio
GRAHAM, CRAIG W., Forest Park, Ill.
GRAHAM, JOHN E., JR., Watertown, Conn.
HALL, LAWRENCE E., Seattle, Wash.
HALL, VICTOR E., Syracuse, N. Y.
HANSELL, J. B., JR., Oakland, Calif.
HANSEN, RAYMOND E., Greensburg, Pa.
HARRISON, BENJAMIN S., Toledo, Ohio
HAUSSNER, W. T., Mt. Vernon, N. Y.
HIX, JULIAN E., Parkersburg, W. Va.
HOLM, JORGEN, New York, N. Y.
HORTON, H. B., El Paso, Texas
HOUSTON, GEORGE L., Binghamton, N. Y.
JAMES, JOHN, Chicago, Ill. (Rt & T)
KEATING, EDWARD, Scarsdale, N. Y.
KEIRE, W. HENRY, Los Angeles, Calif.
KELLER, PHILIP B., Los Angeles, Calif.
KELLOGG, WINSTON T., Birmingham, Mich.
KESKAR, HARISCHANDRA C., Brooklyn, N. Y.
KLINGENSMITH, EARL ELWIN, JR., National City, Calif.
KODAT, ERVIN B., Chicago, Ill.
KOLASKY, CASIMIR, Avenel, N. J.
KOTULA, LOUIS F., Milwaukee, Wis.
LEWIS, RAYMOND JOHN, Syracuse, N. Y.
LOSKY, CHARLES W., Liverpool, N. Y.
MACKENZIE, RICHARD STEEL, New York, N. Y.
MADDOX, DAVID C., Wilmington, Calif.
MARTIN, RANDOLPH B., Newark, N. J.
MASON, WILLIAM W., Cincinnati, Ohio
MAXSON, ROGER W., S. Pasadena, Calif.
MAY, M., Glendale, Calif.
MCJUNKIN, HOWARD P., Charleston, W. Va.
MITCHELL, JAMES DOUGLAS, Baltimore, Md.
MORRIS, J., Cornwall, Ont., Can.
MOSTELLER, WM. C., Los Angeles, Calif.
MOTSINGER, RUSSELL E., Louisville, Ky.
MULVEY, EDWARD T., JR., Winston-Salem, N. C.
NEELEY, ARTHUR CALL, Darien, Conn.
NEUMER, OTTO, Los Angeles, Calif.
NORMAN, EDWARD M., New York, N. Y.
O'HAGAN, R. E., Palatine, Ill.
PAULL, JOHN, Los Angeles, Calif.
PETERS, JACK DOUGLAS, Detroit, Mich.
PETRY, HARRY, Rushville, Ind.
REITEN, PALMER J., Grand Forks, N. Dak.
RHODES, AARON D., Altadena, Calif.
ROBERSON, ROBERT ERROL, St. Louis, Mo.
ROBERTS, L. M., New York, N. Y.
ROEHLK, OTTO H., Arcadia, Calif.
ROGERS, EDGAR A., Chattanooga, Tenn. (Rt)
ROSS, RONALD JOSEPH, Elmhurst, N. Y.
SANTON, ELLIOT A., Worcester, Mass.
SAUNDERSON, H. D., Chevy Chase, Md.
SCHATZ, H. C., Parr, S. C.
SHANMUGAM, S., Bronx, N. Y.
SHANNON, FRANCIS X., JR., Cincinnati, Ohio
SHIPWAY, G. D., San Diego, Calif.
SMURR, FLOYD W., Jackson, Mich.
SNOW, HERBERT E., Roselle, N. J.
SPRENGER, H. D., Columbus, Ohio
STEEL, HARRY FRANKLIN, Ridley Park, Pa.
STEINHAGEN, WILLIAM K., Detroit, Mich.
STONE, HAMILTON LAURIE, San Diego, Calif.
SUNDSTROM, ROY NORMAN, Corning, N. Y.
TSIEN, HSUE-SHEN, Cambridge, Mass.
TURNER, HOWARD ELLIOTT, Wilmington, Del.
ULRICH, HERBERT H., Omaha, Neb.
VOORHIES, EDWIN S., Kingsport, Tenn.
WARD, JOHN KENNETH, W. Los Angeles, Calif.
WEIDNER, W. F., Los Angeles, Calif.
WHEAT, LAWRENCE C., Toledo, Ohio
WIKEN, C. A., Pittsburgh, Pa.
WILLIAMS, OSWALD S., JR., Jamaica, N. Y.
WOOLSEY, W. J., Liberty, Texas
WRIGHT, THOMAS P., Rochester, N. Y.
YEH, ANTHONY Y. C., Syracuse, N. Y.
YOH-HAN, PAO, Syraucse, N. Y.
ZABRISKIE, WILLIAM I., JR., New City, N. Y.
ZACHARIAS, OSCAR C., Cincinnati, Ohio

CHANGE IN GRADING

Transfer to Member

COHEN, ROBERT, Lincoln, Neb.
COLLINS, C. H., Los Angeles, Calif.
DEAL, JOHN ROBE, Wellesley, Mass.
DODGE, CONANT, Tacoma, Wash.
FERRIS, J. M., Montclair, N. J.
FISCHBACH, JOSEPH W., Havre de Grace, Md.

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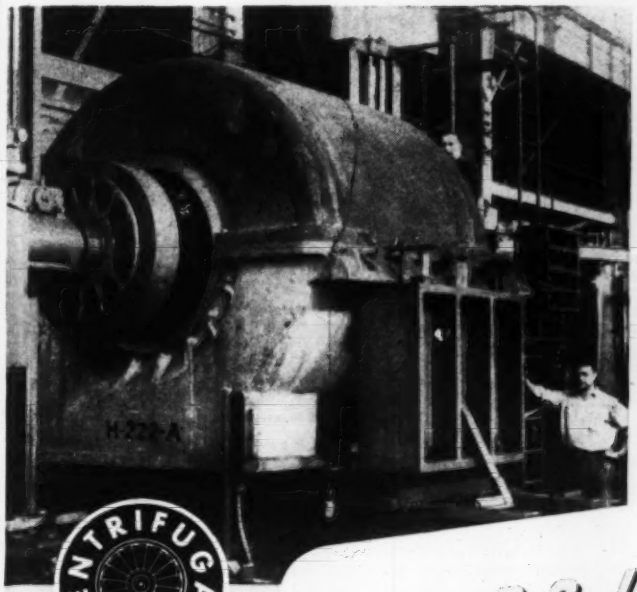
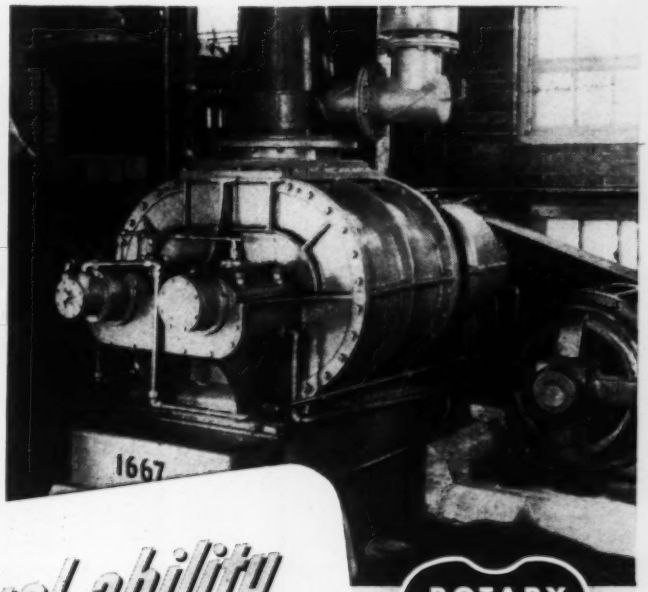


R-C Centrifugal Blower, with capacity of 69,300 CFM, being built in our plant.



R-C Rotary Blower, type RCD, capacity 6,200 CFM.

LET *R-C dual-ability* SETTLE THE QUESTION

If you are in doubt about whether Centrifugal or Rotary Positive units will do the best job of handling gas or air on any specific application, you can obtain an unbiased answer from R-C *dual-ability*.

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Only Roots-Connersville gives you this *dual choice*. It comes from 95 years of designing and building gas and air handling equipment, exclusively.

ROOTS-CONNERSVILLE BLOWER CORPORATION
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FOR HANDLING GAS OR AIR, CALL ON *R-C dual-ability*

No other manufacturer offers such a wide choice of equipment for handling gas and air:

Centrifugal and Rotary Positive Blowers, Exhausters and Boosters

•

Rotary Liquid and Vacuum Pumps

•

Positive Displacement Meters

•

Inert Gas Generators

•

You can depend upon the value of R-C *dual-ability*, because handling air and gas has been our *exclusive* business for 95 years.

★ ★ ★ ★ **ROOTS-CONNERSVILLE** BLOWER BUILDERS R-C SINCE 1854 ★ ★ ★ ★

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★ ★ **ONE OF THE DRESSER INDUSTRIES** ★ ★